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NASA THE X- 70705

A GENERALIZED TECHNIQUE FOR USING CONES AND DIHEDRAL ANGLES IN ATTITUDE DETERMINATION Revision 1

(NASA-TM-X-70705) A GENERALIZED TECHNIQUE FOR USING CONES AND DIHEDRAL ANGLES IN ATTITUDE DETERMINATION, REVISION 1 (NASA) 151 p HC \$10.75 CSCL 22B N74-30314

Unclas G3/31, 54795

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Roger D. Werking

September 1973

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FOREWORD

Over the past several years the Attitude Determination and Control Section has provided support for a number of unmanned scientific and application satellites in the area of attitude determination and attitude control. The satellites have used a variety of sensors and combinations of sensors for use in attitude determination. As a result, an effort was made to develop an attitude determination technique which was capable of handling data from a variety of sensors and produced a general set of solutions from mission to mission. The effort was directed toward reducing the analytical and programming efforts required to support new missions. This document presents the technique which is presently being used by the Attitude Determination Office to meet many of the attitude determination requirements of various missions. The basic analytical work was performed by Mr. L. B. Schlegel of IBM, Federal Systems Division, Federal Systems Center. Gaithersburg, Maryland. The programming of the GCONES subroutine was performed by Mr. F. J. Knoop of IBM. Both efforts were under contract to the Attitude Determination Office. Submitted herein are excerpts from a document written by Mr. Schlegel and Mr. Knoop entitled "GCONES: A Least Squares Geometric Approach to Attitude Determination of a Spinning Satellite" (Reference 1).

Analytic development is presented for a general least squares attitude determination subroutine applicable to spinning satellites. The method is founded on a geometric approach which is completely divorced from considerations relating to particular types and configurations of onboard attitude sensors. Any mix of sensor measurements which can be first transformed (outside the program) to cone or dihedral angle data can be processed. A cone angle is an angle between the spin axis and a known direction line in space; a dihedral angle is an angle between two planes formed by the spin axis and each of two known direction lines. Many different kinds of sensor data can be transformed to these angles, which in turn constitute the actual program inputs, so that the subroutine can be applied without change to a variety of satellite missions. Either a constant or dynamic spin axis model can be handled. The program is also capable of solving for fixed biases in the input angles, in addition to the spin axis attitude solution.

This technique for attitude determination has been used by the Attitude Determination Office to support AE-B, RAE-1, ITOS-1, NOAA-I, SAS-1, IMP-6, San Marco-C (References 2, 3, 4, 5, 6, 7 and 8), SAS-2, IMP-7 and AEROS-1.

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A GENERALIZED TECHNIQUE FOR USING CONES AND DIHEDRAL ANGLES IN ATTITUDE DETERMINATION

1. INTRODUCTION

Since the early 1960's, the Attitude Determination and Control Section of Goddard Space Flight Center has had continuing responsibility for attitude determination of a variety of scientific satellites. Many of these satellites are spin stabilized in orbit, and the primary problem is that of determining the inertial orientation of the spin axis. A number of different types of onboard-measured sensor data are available for this purpose, depending on the particular satellite. Examples are solar aspect sensors, magnetometers, horizon scanners, and star slit scanners. The objective is to obtain a best estimate of the attitude from many individual sensor measurements over some span of the orbit. Although spin-stabilized, the attitude can in general change slowly in time because of disturbances and/or applied control torques. The possible presence of this motion over the data time span must be accounted for in the attitude estimation procedure by a dynamic spin axis motion model.

As described above, the attitude determination problem submits to a standard least squares solution which minimizes the sum of squares of residuals between measured and computed sensor data points. Whenever the relations between sensor observables and attitude state variables are nonlinear, an iterative differential correction procedure must be employed. The computed data are then based initially on an a priori estimated state, and at subsequent iterations on the updated (differentially corrected) state. In some cases, the observables can be linearly related to the state and a one-step, noniterative solution can be obtained without an initial estimate. In either situation, this solution approach usually requires a separate least squares program for each different satellite of interest, because of the distinct sensor complement associated with each. The practical outcome is a considerable duplication of programming work from one satellite attitude determination system to another.

To overcome this redundancy, a technique for attitude determination has been used which reduces the effort required to develop a new support system for each new mission. It was noticed that for many types of sensors flown on spin stabilized satellites, two types of angles were the fundamental measurements of data obtained from the sensors. The first of these angles is commonly referred to as a cone angle and is a measure of the angle between some reference vector and the spin axis. For example, the outputs of (i) a solar aspect sensor, (ii) a magnetometer collinear with the spin axis, and (iii) an infrared horizon scanner, can be

transformed to angles between the spin axis and (i) the sun line, (ii) the earth's magnetic field direction, and (iii) the local vertical line. Each such angle can be regarded as the generating angle of a cone having the known direction as its axis. Thus, a single measurement constrains the spin axis to lie on a conical surface locus. The second of these angles is a dihedral angle demonstrated on the IMP series of satellites. The dihedral angle for those missions is a measurement of the angle between a plane formed by the spin axis and sun line, and the plane formed by the spin axis and the earth's horizon (as sensed by an optical telescope). A dihedral angle measurement defines a different kind of locus surface in space than the conical surface locus of a cone angle.

For a fixed spin axis, this technique (Reference 9) finds the inertial orientation of the least-squares common intersection line of all these loci, using as input only the generating cone-dihedral angles and the associated reference vectors. The method used is iterative differential correction to minimize a weighted sum of squares of residuals between "measured" (that is, transformable from measured sensor data) and computed cone and dihedral angles; an initial or a priori attitude estimate is required. The solution is taken as the best estimate of spin axis attitude using all measured sensor data.

The key idea behind this approach is that the least squares solution algorithm is completely divorced from individual sensor types, onboard mounting angles, etc. Rather, the solution is developed on a strictly geometric basis. Consequently, for each new application, only the transformations from fundamental measurements to cone and dihedral angles need to be specially developed. In this way the technique achieves a significant degree of generality as a fundamental attitude determination tool for spin stabilized spacecraft.

With the use of this technique, new programming is limited to sensor-measure-ment-to-cone angle-dihedral angle transformations. Solutions can be obtained for both static (inertially fixed) and dynamic spin axis motion models. For simplicity, dynamic models, at present are restricted to either linear or quadratic polynomials in time for each of the attitude angles which define spin axis orientation. Here the solution obtained includes attitude angles, rates (linear model), and accelerations (quadratic model) at some epoch time. To provide a better understanding of the data which is being used an option is available for estimating as an additional state parameter, a constant bias in one of the sensor types which contributes to the overall mix of input cone angles.

The ability to estimate bias in addition to attitude has proven to be a useful tool. Inclusion of this mode provides the estimation process with another "degree of freedom," and often results in a better solution "fit" in terms of overall reduction of residuals. In the case of this technique, adherence to the basic design philosophy does not permit particular <u>sensor</u> biases to be appended to the attitude

estimation. Nonetheless, the technique does include full capability of optionally estimating constant biases in the derived cone or dihedral angles, which form the basic inputs. Indeed, separate biases in distinct types of angle data may be estimated simultaneously (see Section 3.1). This approach appears to be the simplest way to incorporate the feature of bias estimation in a technique which is fundamentally sensor-independent. To the extent, however, that sensor measurements may not transform linearly to cone or dihedral angles (prior to using this technique), each constant bias estimated should be cautiously interpreted as no more than a kind of overall or average bias effect of the associated sensor over the entire data span. This interpretation is put on a sounder basis when the data time span is reasonably short. In that case, the approximation of a linear transformation from sensor measurement to geometric angle is more nearly realized.

Differential equation models for dynamic spin axis behavior are included in the technique. This behavior is represented by simple polynomial models (linear, quadratic and cubic) to account for dynamic behavior of each of the attitude angles which define spin axis orientation. These models have proven adequate in past studies whenever the time span of the data being processed is relatively short. The reasoning is that over a sufficiently short span, the true dynamic behavior (of whatever complexity) can be approximated by low order polynomials in time. The polynomial models enjoy the computational advantage that the attitude angles at any time are linearly related to the attitude angles, rates, accelerations, etc. at epoch. These epoch values make up the state vector in the dynamic case. It is realized, however, that in particular situations where the processed data span is necessarily long, or where high disturbance or control torques are acting to change the attitude, another type of model may be needed. This might be based on other kinds of functions (non-polynomial), or more generally on differential equations of motion. The latter requires specification of all torques acting to change the attitude. In particular cases such models may be incorporated without difficulty into the structure to replace the built-in polynomials.

2. DATA CLASSES, TYPES, AND WEIGHTS

From now on the discussion will refer to "measured" or "observed" cone angle and dihedral angle inputs to the technique. It is understood that these angles are not necessarily themselves measured, but are usually transformed (prior to the use of the technique) from actual onboard sensor data.

The input is broken into two basic <u>classes</u> of data: cone angle data (Class 1) and dihedral angle data (Class 2). Within each class there may be any number of distinct types, as for example sun cone angles (cone axis = sun line), magnetic

cone angles (cone axis = magnetic field direction), etc. within the class of cone angles; and similarly for the class of dihedral angles.* Lastly, for each type of data, there can be any number of individual angles. Each measured angle can have any assigned input weight, but each measurement is considered to be independent from all others. Any mixture of numbers, types, and classes of angles constitutes a valid input for a solution run.

The subparagraphs which follow develop the geometric relations between cone or dihedral angles and the spin axis attitude angles at the time of observation. These equations are needed later in the differential correction formulation. The attitude of unit spin axis \underline{S} is consistently defined in terms of right ascension and declination angles α , δ , relative to the standard geocentric inertial system \underline{X} , \underline{Y} , \underline{Z} referred to the vernal equinox. This geometry is shown in Figure 1, with

$$\underline{S} = S_1 \underline{X} + S_2 \underline{Y} + S_3 \underline{Z}$$
 (1)

and

$$S_{1} = \cos \alpha \cos \delta (0^{\circ} \le \alpha \le 360^{\circ}, -90^{\circ} \le \delta \le 90^{\circ})$$

$$S_{2} = \sin \alpha \cos \delta$$

$$S_{3} = \sin \delta$$
(2)

2.1 Cone Angle Data (Class 1)

Cone angles are designated by θ throughout this report. A cone angle is a measure of the angle between \underline{S} and some known unit vector \underline{U} in inertial axes. The vector \underline{U} is regarded as errorless. A single θ measurement constrains \underline{S} to lie on a cone about \underline{U} with generating angle θ , as shown in Figure 2a. A number of θ measurements, and associated cone axes, constrain \underline{S} to lie simultaneously on a number of cones. In general, with imperfect measurements, all cones will not exactly intersect in a common line. The program (with only Class 1 cone angle data input) finds the best common intersection line in the sense of weighted least squares minimization of cone angle residuals, and this line is taken as the solution for \underline{S} . A "top view" of this multiple intersection

^{*}In Section 4.2 of Reference 10, "classes" of data (cone and dihedral angles) are referred to as "types," but the present report will consistently use these designations in the way defined here. The discussion here assumes a fixed spin axis. In the dynamic case all the cones do not have a common intersection, even with perfect θ measurements.

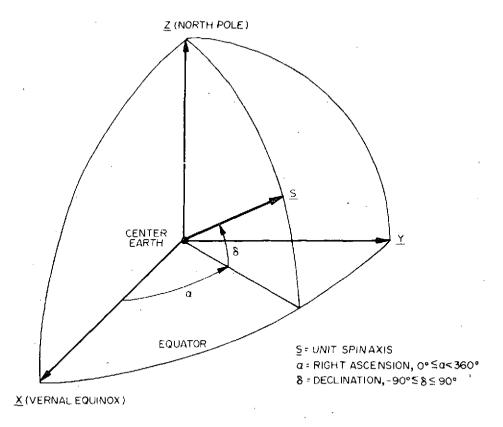


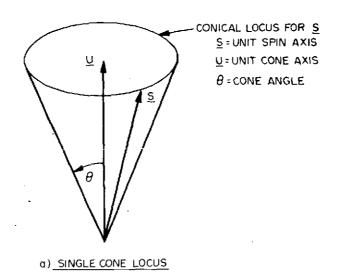
Figure 1. Spin Axis Orientation Angles

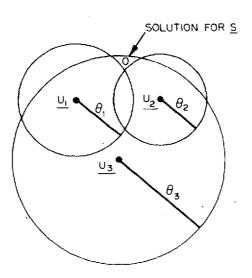
geometry is shown in Figure 2b. With only two cones, two equally valid solutions exist; in this case the program will converge to the intersection line which lies closest in angle separation to the input initial estimate of \underline{S} .

The relation between θ and the spin axis attitude angles α , δ at the time of observation is

$$\theta = \cos^{-1}(U \cdot \underline{S}) = \cos^{-1}(U_1 S_1 + U_2 S_2 + U_3 S_3) + \overline{b_g}$$
 (3)

where $U_{1,2,3}$ are the known X, Y, Z components of \underline{U} and $S_{1,2,3}$ are defined in (2). Whenever bias is to be estimated for a particular type of cone angle data, (3) is augmented by the addition of a bias term b_{θ} on the right, as indicated by the dashed block.





b) TOP VIEW OF MULTIPLE CONE INTERSECTIONS

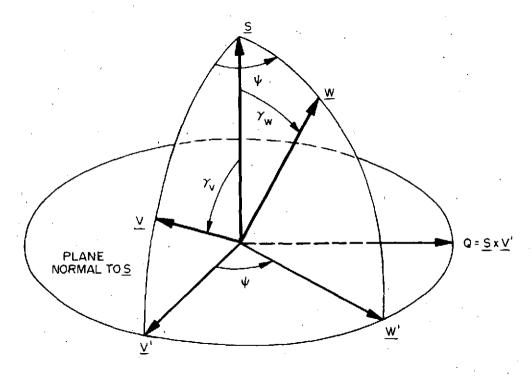
Figure 2. Cone Angle Geometry

2.2 Dihedral Angle Data (Class 2)

Dihedral angles are designated by Ψ throughout this report. A dihedral angle Ψ is a measure of the angle between two planes: the one defined by \underline{S} and a first known unit direction line \underline{V} , the other defined by \underline{S} and a second known unit direction line \underline{W} . The vectors \underline{V} and \underline{W} are regarded as errorless. It is

understood that \underline{S} is not coincident with either \underline{V} or \underline{W} . Geometry is illustrated in Figure 3. The key distinction between dihedral angles and cone angles is that now a single angle Ψ is associated with \underline{two} inertial directions \underline{V} and \underline{W} , and \underline{S} forms the line of intersection of the two planes of interest.*

The sense and range of Ψ , and the ordering of the associated unit vectors \underline{V} and \underline{W} , must be carefully defined for subsequent use. Referring to Figure 3, suppose the given ordering of the unit vectors is \underline{V} , \underline{W} (i.e., \underline{V} "comes first"), and let \underline{V}' , \underline{W}' be unit vectors along the projections of \underline{V} and \underline{W} in a plane normal to \underline{S} . Then Ψ is uniquely defined in the range $0^{\circ} \leq \Psi < 360^{\circ}$ as the angle from \underline{V}' around to \underline{W}' , positive in the sense of positive rotation about \underline{S} . For any type of



S = UNIT SPIN AXIS

V, W = ORDERED PAIR OF KNOWN UNIT DIRECTION LINES

 $\underline{\underline{v}}, \underline{\underline{w}}$ unit vectors along projections of \underline{v} and \underline{w} in plane normal to \underline{s}

Ψ = DIHEDRAL ANGLE BETWEEN SV AND SW PLANES, O° SV < 360°

Figure 3. Dihedral Angle Geometry

^{*}Note that a different kind of dihedral angle can be defined by \underline{S} and two known inertial direction lines \underline{V} and \underline{W} , when either \underline{V} or \underline{W} rather than \underline{S} is common to the two planes which intersect at the given angle. POLANG data from the ATS satellite series is an example of such a dihedral angle (Reference 11).

sensor data transformable to Ψ angles, an ordering of the known \underline{V} and $\underline{\underline{W}}$ direction lines must be specified, and the magnitude of measured Ψ must be in accord with this ordering and the above definition.

The relation between Ψ and the attitude angles α , δ of \underline{S} at the time of observation can be developed from the geometry of Figure 3. First define the auxiliary angles $\gamma_{\rm v}$, $\gamma_{\rm w}$ in the range 0° to 180° by

$$\cos \gamma_{\mathbf{w}} = \underline{\mathbf{V}} \cdot \underline{\mathbf{S}}, \quad \cos \gamma_{\mathbf{w}} = \underline{\mathbf{W}} \cdot \underline{\mathbf{S}}$$
 (4)

and the auxiliary unit vector \underline{Q} in the plane normal to \underline{S} by

$$Q = S \times V' \tag{5}$$

Then

$$\underline{\mathbf{V}}' = \frac{1}{\sin \gamma_{\mathbf{V}}} (\underline{\mathbf{V}} - \cos \gamma_{\mathbf{V}} \underline{\mathbf{S}}) \tag{6}$$

$$\underline{\underline{W}}' = \frac{1}{\sin \gamma_{\underline{W}}} (\underline{\underline{W}} - \cos \gamma_{\underline{W}} \underline{\underline{S}})$$
 (7)

$$Q = \underline{S} \times \underline{V}' = \frac{1}{\sin \gamma_{\mathbf{v}}} \cdot (\underline{S} \times \underline{V})$$
 (8)

$$\Psi = \tan^{-1}\left(\frac{\underline{W}' \cdot \underline{V}}{\underline{W}' \cdot \underline{V}'}\right), \ 0^{\circ} \le \Psi < 360^{\circ} \text{ unambiguously}$$
by sign of numerator and (9)

denominator

Substituting from (4), (6), (7), and (8) into (9) and simplifying,

$$\Psi = \tan^{-1} \left[\frac{\underline{\underline{W}} \cdot (\underline{\underline{S}} \times \underline{\underline{V}})}{\underline{\underline{V}} \cdot \underline{\underline{W}} - \cos \gamma_{\underline{V}} \, \underline{\underline{W}} \cdot \underline{\underline{S}} - \cos \gamma_{\underline{W}} \, \underline{\underline{V}} \cdot \underline{\underline{S}} + \cos \gamma_{\underline{V}} \cos \gamma_{\underline{W}}} \right]$$

$$= \tan^{-1} \left[\frac{\underline{\underline{S}} \cdot (\underline{\underline{V}} \times \underline{\underline{W}})}{\underline{\underline{V}} \cdot \underline{\underline{W}} - (\underline{\underline{V}} \cdot \underline{\underline{S}}) \, (\underline{\underline{W}} \cdot \underline{\underline{S}})} \right]$$
(10)

where the factor ($\sin \gamma_{\rm V} \sin \gamma_{\rm W}$) has been divided out from the numerator and denominator without loss of quadrant selectivity, since both $\sin \gamma_{\rm V}$ and $\sin \gamma_{\rm W}$ are positive for $0^{\circ} \le \gamma_{\rm V}$, $\gamma_{\rm W} \le 180^{\circ}$. Finally, letting $V_{\rm 1, 2.3}$ and $W_{\rm 1, 2.3}$ be the known X, Y, Z components of V and W, (10) reduces to

$$\Psi = \tan^{-1} \left[\frac{S_1 \left(V_2 W_3 - V_3 W_2 \right) + S_2 \left(V_3 W_1 - V_1 W_3 \right) + S_3 \left(V_1 W_2 - V_2 W_1 \right)}{\left(V_1 W_1 + V_2 W_2 + V_3 W_3 \right) - \left(V_1 S_1 + V_2 S_2 + V_3 S_3 \right) \left(W_1 S_1 + W_2 S_2 + W_3 S_3 \right)} \right] \frac{1}{\left[+ b_{\Psi} \right]} (11)$$

where $S_{1,\,2,\,3}$ are defined in (2). Equation (11) is the desired relation between Ψ and α , δ . Whenever bias is to be estimated for a particular type of dihedral angle data, (11) is augmented by the addition of a bias term b_{Ψ} on the right, as indicated by the dashed block.

Before concluding this section, a few remarks on the concept of a "dihedral angle locus" are in order. In the same way that a single cone angle θ cannot uniquely determine the spin axis, but only defines a locus for S, so also a single dihedral angle Ψ defines a different kind of locus. It is generally of more complicated character than the cone of Figure 2a. To demonstrate that a locus indeed exists, it is instructive to consider the specific case shown in Figure 4, where V and W are separated by 45° and $\Psi = 60^{\circ}$. This figure is drawn differently from Figure 3, in that it is referenced to the plane of V and W as "equator" plane, with N the unit normal to this plane. Now along every meridian extending from \underline{N} to the equator arc bounded by \underline{A} and \underline{B} , there must exist a direction S such that the dihedral angle between planes S V and S W is equal to $\Psi = 60^{\circ}$. This follows since as \underline{S} proceeds from \underline{N} down along every such meridian, Ψ opens up from $\Psi = 45^{\circ}$ (when S = N) to either $\Psi = 180^{\circ}$ (when S lies in the equator plane between \underline{V} and \underline{W}) or $\Psi = 90^{\circ}$ (when $\underline{S} = \underline{V}$ or $\underline{S} = \underline{W}$). Two particular points on this locus are shown as \underline{S}_1 and \underline{S}_2 on the meridian arcs NV and NW, and a segment of the locus is sketched between.

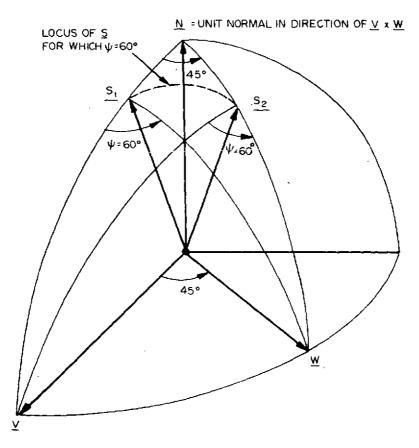


Figure 4. Spin Axis Locus (Single Dihedral Angle)

Note that this locus is not a "circle of latitude." Nor, apparently, is it part of a (right circular) cone. That is, there is no single direction line in space which could serve as cone axis; such a line must have the property that all \underline{S} orientations along the locus are separated from it by a constant angle (the cone angle). Nevertheless, the surface swept out by \underline{S} as it occupies all points on the locus can be considered in a general sense to be part of (non-right-circular) "cone."

A number of dihedral angles alone (without any additional cone angles) suffices for a solution, since all of the lociso defined have a nearly common intersection line.* With only Class 2 dihedral angle inputs, the technique finds the best common intersection in the sense of weighted least squares minimization of dihedral angle residuals. This is taken as the solution for S. In the most general case, any mixture of Class 1 and Class 2 data may be input, and the program finds the best common intersection of all cone angle and dihedral angle loci.

^{*}The discussion here again assumes a fixed spin axis, but the program also handles the dynamic case (Section 3).

3. SPIN AXIS MOTION MODEL

3.1 Constant and Dynamic Models

The most common application of the technique is the case of constant \underline{S} . That is, the acting torque levels are sufficiently small, or the data span is sufficiently short, that \underline{S} can be regarded as inertially fixed over the span. The attitude state is then simply defined by α and δ . If these conditions are not well satisfied, a dynamic motion model based on low order polynomials in time is assumed for α and δ , viz.

$$\alpha(t) = a_0 + a_1 (t - t_0) + a_2 (t - t_0)^2 + a_3 (t - t_0)^3$$

$$\delta(t) = d_0 + d_1 (t - t_0) + d_2 (t - t_0)^2 + d_3 (t - t_0)^3$$
(12)

where t_0 is a chosen epoch time and t is a general time within the data span. The advantage of polynomial models in the least-squares solution algorithm is that the attitude angles at times t are linearly related to the a_0 , a_1 , ..., d_3 state coefficients. Considerable computational simplicity is thereby realized (see Section 4).

Logic allows for truncations of (12) to quadratic, linear, or constant models at the option of the user, so that the case of constant \underline{S} is also handled by the general form (12). To summarize, the state variables estimated by this technique for the various motion models are as follows:

STATE DEFINITION

| Model | State Variables | |
|-----------|---|------|
| Constant | a _o , d _o | |
| Linear | a ₀ , d ₀ , a ₁ , d ₁ | (13) |
| Quadratic | a ₀ , d ₀ , a ₁ , d ₁ , a ₂ , d ₂ | |
| Cubic | a ₀ , d ₀ , a ₁ , d ₁ , a ₂ , d ₂ , a ₃ , d ₃ | |

At option, constant biases on separate types of either cone angle (Class 1) or dihedral angle (Class 2) data may be included as additional state parameters and estimated along with the attitude variables. As many as <u>five</u> distinct biases may be simultaneously estimated, apportioned in any way among the separate data types of either data class.

3.2 Nutation Application

By their very nature, polynomial models tend to fit the general trend of a dynamic motion process, and to filter out short period oscillations. A particular instance of the latter, which is of some importance in practice, occurs when space nutation is present. Here S executes coning motion about the total angular momentum H, and it is the attitude motion of H under various torques that is often wellapproximated over a data span by polynomial models. The measured cone and/ or dihedral angles, however, are relative to S. Consequently, they will exhibit an oscillatory component at the nutation period, which is in accord with the actual motion of S. Now if (i) the nutation cone angle is small, (ii) the nutation period is short compared to the period required for \underline{H} to change appreciably in direction, and (iii) many measured data points occur over each nutation cycle, then the inherent smoothing action of this technique tends to give a good estimate of the motion of H. The solution can then be interpreted as the average or smoothed motion of the nutating spin axis S. This holds for both constant and dynamic models for H. The above conditions (i), (ii), (iii) are indeed often satisfied in practice, which implies that the simple polynomial models are capable of providing at least average solutions for S in the presence of nutation. For a particular application of these considerations to the TIROS-M satellite, see pp. 4-37 to 4-41 of Reference 4.

4. LEAST SQUARES SOLUTION ALGORITHM

4.1 Basic Formulation

The attitude and optional bias solutions obtained by this technique are those which minimize a weighted sum J of squared residuals between measured and computed cone angles and dihedral angles. The minimization is carried out with respect to the attitude state variables (13), plus any specified bias parameters. In vector-matrix form, the sum J is

$$J = (\widetilde{\underline{\theta}} - \underline{\theta})' [W_{\theta}] (\widetilde{\underline{\theta}} - \theta) + (\widetilde{\underline{\Psi}} - \underline{\Psi})' [W_{\underline{\Psi}}] (\widetilde{\underline{\Psi}} - \underline{\Psi})$$
 (14).

where

 $\underline{\widetilde{\theta}}$ = vector of cone angle measurements (hereafter the tilde(\sim) notation indicates a measured quantity; elements of $\underline{\widetilde{\theta}}$ together with corresponding measurements times are input to the program)

 θ = vector of computed cone angles

 $[W_a]$ = diagonal matrix of cone angle weights (input)

 $\underline{\widetilde{\Psi}}$ = vector of dihedral angle measurements (input together with corresponding measurement times)

 Ψ = vector of computed dihedral angles

[Wud] = diagonal matrix of dihedral angle weights (input)

and prime (') indicates transpose. The elements of $\underline{\theta}$ and $\underline{\psi}$ are computed as functions of the attitude state (and possibly bias) parameters according to (3) and (11), together with the defining relations (2) and (12).

Following Reference 12, the minimization of J is achieved iteratively through the differential correction algorithm

$$\Delta \underline{\mathbf{x}} = \{ [\mathbf{H}]' [\mathbf{W}] [\mathbf{H}] \}^{-1} [\mathbf{H}]' [\mathbf{W}] \underline{\rho}$$
 (15)

where

 $\underline{\mathbf{x}}$ = state vector (consisting of components (13) plus specified biases to be estimated)

[H] = matrix of partials of cone and dihedral angles with respect to the elements of the state vector

[W] = diagonal weighting matrix whose diagonal partitions are [W $_{\theta}$] and [W $_{\Psi}$], i.e.,

$$[\mathbf{W}] = \begin{bmatrix} [\mathbf{W}_{\theta}] & \mathbf{0} \\ --- & --- \\ \mathbf{0} & [\mathbf{W}_{\Psi}] \end{bmatrix}$$
 (16)

 ρ = vector of all cone and dihedral angles residuals,

$$\varrho = \begin{bmatrix} \widetilde{\theta} - \theta \\ \widetilde{\Psi} - \Psi \end{bmatrix} \tag{17}$$

In the above, [H] and $\underline{\rho}$ at each iteration are evaluated for the current state estimate $\underline{\hat{\mathbf{x}}}$ at that iteration (hereafter the hat (^) notation indicates an estimate). The process begins at an input initial state estimate $\underline{\hat{\mathbf{x}}}_0$, which is updated to $\underline{\hat{\mathbf{x}}} = \underline{\hat{\mathbf{x}}}_0 + \Delta \, \underline{\mathbf{x}}$ after the first iteration, etc. (see Section 4.4) for additional details).

4.2 Partial Derivatives

The partial derivatives which go to make up the elements of [H] are obtained by chain-rule differentiations of (3) and (11) taken together with (2) and (12). A simple example will first be given to illustrate the procedure; extensions to more general cases follow. Suppose that (i) the dynamic model (12) is linear, (ii) only one type of Class 1 θ data is being processed, and (iii) bias in this data type is also to be estimated. Then the state parameters for the problem are a_0 , d_0 , a_1 , d_1 , and b_θ . The relation between θ and these parameters is therefore expressed by the system of equations

$$\theta = \cos^{-1} (U_1 \cos \alpha \cos \delta + U_2 \sin \alpha \cos \delta + U_3 \sin \delta) + b_{\theta}$$
 (18)

$$a = a_0 + a_1 (t - t_0)$$
 (19)

$$\delta = d_0 + d_1 (t - t_0)$$
 (20)

From (18-20) the appropriate partial derivatives are

$$\frac{\partial \theta}{\partial a_0} = \frac{-U_1 \sin \alpha \cos \delta + U_2 \cos \alpha \cos \delta}{-\sqrt{1 - (U_1 \cos \alpha \cos \delta + U_2 \sin \alpha \cos \delta + U_3 \sin \delta)^2}}$$
(21)

$$\frac{\partial \theta}{\partial d_0} = \frac{-U_1 \cos \alpha \sin \delta - U_2 \sin \alpha \sin \delta + U_3 \cos \delta}{-\sqrt{1 - (U_1 \cos \alpha \cos \delta + U_2 \sin \alpha \cos \delta + U_3 \sin \delta)^2}}$$
(22)

$$\frac{\partial \theta}{\partial \mathbf{a_1}} = \frac{\partial \theta}{\partial \mathbf{a_0}} (\mathbf{t} - \mathbf{t_0}) \tag{23}$$

$$\frac{\partial \theta}{\partial d_1} = \frac{\partial \theta}{\partial d_0} (t - t_0)$$
 (24)

$$\frac{\partial \theta}{\partial \mathbf{b}_{a}} = \mathbf{1} \tag{25}$$

where α and δ are functions of a_0 , a_1 , d_0 , d_1 given by (19) and (20).

For this example, assuming n data points $\widetilde{\theta}_1, \ldots, \widetilde{\theta}_n$ at measurements times t_1, \ldots, t_n , matrix [H] is of order nx5, with the i-th row consisting of the elements (21-25) evaluated at time t_i .

It is seen that (21) and (22) are the "fundamental" partials for a constant spin axis model, with (23) and (24) being obtained from them by multiplying by $(t-t_0)$. Extending this sample to a quadratic or a cubic motion model, the required additional partials are

$$\frac{\partial \theta}{\partial \mathbf{a}_{2}} = \frac{\partial \theta}{\partial \mathbf{a}_{0}} (\mathbf{t} - \mathbf{t}_{0})^{2}$$

$$\frac{\partial \theta}{\partial \mathbf{a}_{3}} = \frac{\partial \theta}{\partial \mathbf{a}_{0}} (\mathbf{t} - \mathbf{t}_{0})^{3}$$

$$\frac{\partial \theta}{\partial \mathbf{d}_{2}} = \frac{\partial \theta}{\partial \mathbf{d}_{0}} (\mathbf{t} - \mathbf{t}_{0})^{2}$$

$$\frac{\partial \theta}{\partial \mathbf{d}_{3}} = \frac{\partial \theta}{\partial \mathbf{d}_{0}} (\mathbf{t} - \mathbf{t}_{0})^{3}$$
(26)

Following this same approach, the fundamental partials for dihedral angle data are $\partial \Psi/\partial a_0$, $\partial \Psi/\partial d_0$. These are obtained by differentiations of (11), with $S_{1,2,3}$ given by (2). The algebra is straightforward but somewhat lengthy, so only the final results are given here. For brevity of notion, define

$$\begin{bmatrix}
 E_1 = V_2 W_3 - V_3 W_2 \\
 E_2 = V_3 W_1 - V_1 W_3 \\
 E_3 = V_1 W_2 - V_2 W_1
 \end{bmatrix}$$
(27)

$$F = V_1 W_1 + V_2 W_2 + V_3 W_3$$
 (28)

$$S_{V} = V_{1} S_{1} + V_{2} S_{2} + V_{3} S_{3}$$

$$S_{W} = W_{1} S_{1} + W_{2} S_{2} + W_{3} S_{3}$$
(29)

NUM (for "Numerator") =
$$S_1 E_1 + S_2 E_2 + S_3 E_3$$

DEN (for "Denominator") = $F - S_V S_W$
(30)

Thus (11) becomes

$$\Psi = \tan^{-1}\left(\frac{\text{NUM}}{\text{DEN}}\right)\Big|_{---}^{+---} + b_{\Psi}\Big|$$
 (31)

Further define

$$Q_{1} = DEN \cdot E_{1} + NUM (S_{V} W_{1} + S_{W} V_{1})$$

$$Q_{2} = DEN \cdot E_{2} + NUM (S_{V} W_{2} + S_{W} V_{2})$$

$$Q_{3} = DEN \cdot E_{3} + NUM (S_{V} W_{3} + S_{W} V_{2})$$
(32)

Then the fundamental dihedral partials are

$$\frac{\partial \Psi}{\partial a_0} = \frac{-Q_1 \sin \alpha \cos \delta + Q_2 \cos \alpha \cos \delta}{(\text{NUM})^2 + (\text{DEN})^2}$$
 (33)

$$\frac{\partial \Psi}{\partial d_0} = \frac{-Q_1 \cos \alpha \sin \delta - Q_2 \sin \alpha \sin \delta + Q_3 \cos \delta}{(\text{NUM})^2 + (\text{DEN})^2}$$
(34)

where a and δ are functions of a_0 , ..., d_3 given by (12). Additional partials to accommodate a dynamic motion model are obtained by multiplying (33) and (34) by appropriate powers to $(t - t_0)$, as in (23), (24), (26).

To summarize for all cases, the following table lists the partial derivative equations used in computing the elements of [H].

PARTIAL DERIVATIVE TABULATION

| Cone Angle Partials | Equation | Dihedral Angle Partials | Equation | Model | | | | | | |
|---|--|-------------------------------|------------------------------|-----------|--|--|--|--|--|--|
| $\frac{\partial \theta}{\partial \mathbf{a_0}}$ | (21) | <u>д Ф</u> | (33) | Constant | | | | | | |
| θ 6 θ 6 | (22) | 9 q ⁰ 9 Ψ | (34) | Constant | | | | | | |
| $\frac{\partial a_1}{\partial a_1}$ | $(21) \cdot (\mathbf{t} - \mathbf{t}_0)$ | <u>∂Ψ</u> ∂a ₁ | (33) · (t - t ₀) | Linear | | | | | | |
| $\frac{\partial \theta}{\partial \mathbf{d_1}}$ | $(22) \cdot (t - t_0)$ | <u>∂Ψ</u> | (34) · (t - t _o) | | | | | | | |
| · <u>3 9</u> | $(21) \cdot (t - t_0)^2$ | <u>θΨ</u> | $(33) \cdot (t - t_0)^2$ | Quadratic | | | | | | |
| $\frac{\partial \theta}{\partial \mathbf{d_2}}$ | $(22) \cdot (t - t_0)^2$ | ∂Ψ ∂d ₂ | $(34) \cdot (t - t_0)^2$ | | | | | | | |
| $\frac{\partial \theta}{\partial a_3}$ | $(21) \cdot (t - t_0)^3$ | <u>∂</u> Ψ ∂а ₃ | $(33) \cdot (t - t_0)^3$ | Cubic | | | | | | |
| 9 q ³ | $(22) \cdot (t - t_0)^3$ | <u>∂Ψ</u> | $(34) \cdot (t - t_0)^3$ | | | | | | | |

In addition to the above, [H] also contains partials of θ or Ψ with respect to biases for particular data types. If bias for a particular type of θ or Ψ data is being estimated, the appropriate partial (either $\partial\theta/\partial b_{\theta}$ or $\partial\Psi/\partial b_{\Psi}$) is unity; otherwise it is zero.

4.3 Computation Structure for Mixed Classes and Types of Data

As stated earlier, this technique can handle any number of different data types within each data class. Within each type there can be any number of individual cone or dihedral angles. For additional clarification, it is helpful to examine a specific case here, which also serves to illustrate how bias estimation on particular data types is processed.

Suppose that 5 cone angles of one type, 8 cone angles of another type, and 6 dihedral angles of one type are input. To avoid complicated subscripting, designate the cone angle types by θ and ϕ , and the dihedral angle type by Ψ . Thus, the input data sets are $\widetilde{\theta}_1, \ldots, \widetilde{\theta}_5$; $\widetilde{\phi}_1, \ldots, \widetilde{\phi}_8$; Ψ_1, \ldots, Ψ_6 . Let the 19 corresponding measurement times be $t_{\theta 1}$, $t_{\theta 2}$, ..., $t_{\Psi 6}$. Also assume a linear dynamic model, and suppose that bias b_{ϕ} on just the second type of cone angle data is also to be estimated. Then the state vector is

$$\frac{\mathbf{x}}{\mathbf{x}} = [\mathbf{a_0} \ \mathbf{d_0} \ \mathbf{a_1} \ \mathbf{d_1} \ \mathbf{b_\theta}] \, ' \tag{35}$$

and the vectors and matrices in the differential correction algorithm (15) are structured as follows:

$$\overset{5\times1}{\triangle} \underline{\mathbf{x}} = [\triangle \mathbf{a}_0 \quad \triangle \mathbf{d}_0 \quad \triangle \mathbf{a}_1 \quad \triangle \mathbf{d}_1 \quad \triangle \mathbf{b}_{\phi}]$$
 (36)

$$\begin{bmatrix} \frac{\partial \theta_{1}}{\partial \mathbf{a}_{0}} & \cdots & \frac{\partial \theta_{1}}{\partial \mathbf{d}_{1}} & 0 \\ \vdots & \vdots & \ddots & \vdots \\ \vdots & \vdots & \ddots & \vdots \\ \frac{\partial \theta_{5}}{\partial \mathbf{a}_{0}} & \cdots & \frac{\partial \theta_{5}}{\partial \mathbf{d}_{1}} & 0 \end{bmatrix}$$

$$\begin{bmatrix} \frac{\partial \theta_{5}}{\partial \mathbf{a}_{0}} & \cdots & \frac{\partial \theta_{5}}{\partial \mathbf{d}_{1}} & 0 \\ \vdots & \vdots & \ddots & \vdots \\ \frac{\partial \phi_{8}}{\partial \mathbf{a}_{0}} & \cdots & \frac{\partial \phi_{8}}{\partial \mathbf{d}_{1}} & 1 \\ \vdots & \vdots & \ddots & \vdots \\ \frac{\partial \phi_{8}}{\partial \mathbf{a}_{0}} & \cdots & \frac{\partial \phi_{8}}{\partial \mathbf{d}_{1}} & 0 \end{bmatrix}$$

$$\begin{bmatrix} \frac{\partial \phi_{8}}{\partial \mathbf{a}_{0}} & \cdots & \frac{\partial \phi_{8}}{\partial \mathbf{d}_{1}} & 1 \\ \vdots & \vdots & \ddots & \vdots \\ \frac{\partial \phi_{6}}{\partial \mathbf{a}_{0}} & \cdots & \frac{\partial \phi_{6}}{\partial \mathbf{d}_{1}} & 0 \end{bmatrix}$$

$$(37)$$

$$\begin{bmatrix} \mathbf{W}_{\theta 1} & & & & & \\ & \ddots & & & & \\ & & \mathbf{W}_{\theta 5} & & & & \\ & & & \mathbf{W}_{\phi 1} & & & \\ & & & & & \\ & & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & \\ & & & & \\ & & & \\ & & & \\ & & & & \\ & & &$$

$$\mathcal{L}^{19\times1} = \left[\widetilde{\theta}_{1} - \theta_{1} \cdots \widetilde{\theta}_{5} - \theta_{5}\right] \left[\widetilde{\phi}_{1} - \phi_{1} \cdots \widetilde{\phi}_{8} - \phi_{8}\right] \left[\widetilde{\Psi}_{1} - \Psi_{1} \cdots \widetilde{\Psi}_{6} - \Psi_{6}\right]$$
(39)

The partials in (37) and computed angles θ , ϕ , Ψ in (39) are evaluated about the current state estimates \hat{a}_0 , ..., \hat{d}_1 , \hat{b}_{ϕ} at the iteration in question. Relevant equations are (2), (3), (11), and the linear version of (12), with t in (12) replaced by the appropriate measurement time from the set $t_{\theta 1}$, ..., $t_{\Psi 6}$.

4.4 Iterations and Convergence Criteria

Starting with an input state estimate $\hat{\mathbf{x}}_0$, (15) is implemented iteratively, with the estimate $\hat{\mathbf{x}}$ at each step replaced by $\hat{\mathbf{x}} + \Delta \mathbf{x}$ for the succeeding step. The process continues until the state corrections $(\Delta \mathbf{a}_0, \ldots, \Delta \mathbf{d}_1, \Delta \mathbf{b}_\phi)$ in the preceding example) are simultaneously less in absolute value than individually assigned input bounds. This defines convergence, and the updated state after addition of these final corrections is taken as the attitude (and bias) solution. The operation also ends if convergence has not occurred after a certain maximum number of iterations, which is assigned as an input parameters.

Because of the way in which a Ψ angle is defined (Section 2.2), a "boundary line" discontinuity exists at $\Psi=0$ which can cause erroneously high residuals to occur near this point. For instance, if measured $\widetilde{\Psi}=1^\circ$ and computed $\Psi=359^\circ$, then formally the residual is $\widetilde{\Psi}-\Psi=358^\circ$, whereas actually a corrected residual of $+2^\circ$ is desired. This condition is handled with proper logical control.

4.5 Data Rejection Procedures

Though the techniques used in GCONES and in DCCONS (graphics counterpart of GCONES) are similar, both will be described in this section for completeness.

4.5.1 Residual Editing Method of GCONES

Due to the variety and nature of sensors and types of data which can use this technique some method of screening input data for consistency is desirable. The following residual editing method has been incorporated to be exercised at user option.

The average angle residual for each type of data in both classes is calculated by

$$\rho_{AUG} = \underbrace{\sum_{i=1}^{n} |\rho_i|}_{n} \tag{40}$$

where n is the number of angles of the particular type.

Then these average angle residuals for all types are averaged to obtain an average residual for all data. The editing process continues by comparing the individual angle residuals to an input multiple of the computed average angle residual for all data. All angles whose residuals are higher than the specified multiple of the average have the associated weights set equal to 0.0 and are thus not considered in the remainder of the computations.

4.5.2 Residual Editing Method of DCCONS

The present writeup will use the symbol K to indicate any set of cone or dihedral angle data which contains at least one "useful" data point. The K notation will be convenient here because it eliminates the necessity of referring to the cone and dihedral angle data classes separately. Let M indicate the total number of such data sets. Then K = 1, 2 - M. Let α_K indicate the "useful" data points in set K and let N_K be the total number of such points in set K. Then $\alpha_K = 1, 2, - M$. In the preliminary computations of its residual editing operation, DCCONS

considers the "useful" data points to be those whose time is not flagged and (2) whose weight WGHT (K,α) is greater than or equal to zero.

Let RHO (K,α_K) be the residual of data point α_K . RHO (K,α_K) is defined to be

RHO
$$(K, \alpha_K) = GAMMA(K, \alpha_K) - THETA(K, \alpha_K)$$
.

where GAMMA (K, α_K) and THETA (K, α_K) are the measured and estimated cone or dihedral angles respectively of point α_K .

The residual editing is performed in GSTAT1. The user specifies the residual editing option by setting IOC to 1. When the option is used, a quantity AVGRHO is computed for each data set. The AVGRHO of any data set which contains no useful points (i.e. no points whose times are not flagged) is set to zero. The AVGRHO's of the other sets (K) is computed by

AVGRHO (K) =
$$\frac{1}{N_K} \sum_{\alpha_K = 1}^{N_K} |RHO(K, \alpha_K)|$$
 (1)

The summation in Eq. (1), as well as N_K , includes all data points whose time is not flagged.

The next step in the current residual editing option of DCCONS is the computation of the numerical values of two quantities designated as SUMAV and AVG

$$SUMAV = \sum_{K \ge 1}^{M} AVGRHO(K)$$
 (2)

$$AVG = \frac{1}{M} * SUMAV$$
 (3)

The final step in the residual editing operation is to multiply by -1 the weights of all data points whose residual is greater in magnitude than ISMULT * AVG. All data points (including those whose weight previously was set negative) are checked. After the weight of a data point has once been set to less than zero, it can never be reset to a positive value. The weights of data points whose time is flagged are not necessarily set to less than zero by the residual editing operation; such points are eliminated from processing in COFSM by other logic.

4.6 Statistical Information

Many types of evaluative criteria can be associated with least squares differential correction processes. In order to keep the basic technique as simple as possible, however, the statistical parameters are confined to the following standard fundamental forms.

• Covariance matrix of errors in the converged state estimate. This is given by (see Reference 9)

$$[\Lambda] = \{ [H] ' [W] [H] \}^{-1}$$
(41)

which is a direct by-product of the differential correction algorithm (15).

• Weighted mean of residuals for each data type in both Classes 1 and 2, given by (see Reference 13)

$$\widetilde{\rho} = \frac{\sum_{i} \mathbf{W}_{i} \ \rho_{i}}{\sum_{i} \mathbf{W}_{i}}$$
 (42)

Thus for the example of Section 4.3, the weighted means are

$$\overline{\rho}_{\theta} = \frac{\sum_{i=1}^{5} W_{\theta i} (\widetilde{\theta}_{i} - \theta_{i})}{\sum_{i=1}^{5} W_{\theta i}}$$

$$(43)$$

$$\overline{\rho}_{\phi} = \frac{\sum_{i=1}^{8} W_{\phi_{i}} (\widetilde{\phi}_{i} - \phi_{i})}{\sum_{i=1}^{8} W_{\phi_{i}}}$$
(44)

$$\widetilde{\rho}_{\Psi} = \frac{\sum_{i=1}^{6} W_{\Psi_{i}} (\widetilde{\Psi}_{i} - \Psi_{i})}{\sum_{i=1}^{6} W_{\Psi_{i}}}$$

$$(45)$$

• Weighted RMS (root-mean-square) of residuals for each data type in both Classes 1 and 2. Based on the material in Reference 13, this is defined in the program by

$$\sigma = \frac{\left[\sum_{\mathbf{W}_{i}} (\rho_{i} - \overline{\rho})^{2}\right]^{1/2}}{\sum_{\mathbf{W}_{i}} \rho_{i}^{2} - 2 \overline{\rho} \sum_{\mathbf{W}_{i}} W_{i} \rho_{i}} + \frac{\overline{\rho}^{2} \sum_{\mathbf{W}_{i}} W_{i}}{\sum_{\mathbf{W}_{i}} W_{i}} + \frac{1/2}{\sum_{\mathbf{W}_{i}} W_{i}}$$

$$(46)$$

Using (42), Equation (46) becomes

$$\sigma = \left(\frac{\sum_{i} W_{i} \rho_{i}^{2}}{\sum_{i} W_{i}} - \overline{\rho}^{2}\right)^{1/2}$$
(47)

For the example of Section 4.4,

$$\sigma_{\theta} = \begin{bmatrix} \sum_{i=1}^{5} W_{\theta i} & (\widetilde{\theta}_{i} - \theta_{i})^{2} \\ \vdots & \sum_{i=1}^{5} W_{=i} \end{bmatrix}$$
(48)

ullet Sum of weights ΣW_i for each data type in both Classes 1 and 2. When several different types of data are used, these sums give a general indication of the relative contribution of each data type to the final solution.

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APPENDIX A

C. NAME: SUBROUTINE GCONES - GENERALIZED CONES С. C. C. AUTHÉR: F. KNCCP. IBM C. PURPOSE: C-C. THIS SUBROUTINE COMPLTES THE SPIN AXIS ATTITUDE OF A SPACE-C. C. CRAFT FROM SEIS OF CONE ANGLES AND KNOWN AXES AND/OR SETS OF C. BE DETERMINED MAY, AT OPTION, BE THE COEFFICIENTS OF TIME DEP-. CIHÉCRAL ANGLES AND KNOWN VECTORS. THE SPIN AXIS ATTITUDE TO . C. ENDENT POLYNOMIALS IN ALPHA AND DELTA. ANOTHER IMPORTANT FEATURE ALLOWS DETERMINATION OF CONSTANT BIASES IN THE CONE C. ANCIER DIHEDRAL ANGLES. THE METHOD EMPLOYED IS ITERATIVE LIN-EAR CIFFERENTIAL CORRECTION. · C • C. - COMPUTER: S/360, CORE: 16K, COMPILER: FORTRAN-H C. C . . C. CALLING SEQUENCE EXPLANATION: C. TZERC - THE INPUT REFERENCE TIME FOR THE ALPHA AND CELTA C. POLYNCMIALS, I.E.: C. ALPHA(T)= AC + A1*(T+TZERO) + A2*(T+TZERO)**2 + ... C. - AN INPUT ARRAY CONTAINING THE INITIAL ESTIMATES OF C. ALP THE ALPHA CCEFFICIENTS TO BE SOLVED FOR. ON RETURN C. C. THIS ARRAY WILL CONTAIN THE FINAL VALUES DETERMINED BY CCCNES (UNITS OF DEGS, DEGS/TIME, DEGS/TIME**2. C. ETC. WHERE THE UNIT OF TIME IS THE SAME AS FOR TIME!.. C. TIME2, 1ZERC, DEL) C. - SAME AS ALP BUT FOR DELTA COEFFICIENTS C. CEL C. C. ALPBND - AN INPUT ARRAY CONTAINING THE LOWER BOUNDS FOR CORR-ECTION TO THE ALPHA COEFFICIENTS. CONVERGENCE OCCURS. C. WHEN ALL COFRECTIONS ARE SIMULTANEOUSLY LESS THAN ·C • 7 THEIR CERRECTION BOUNDS C. C. DELBND - SAME AS ALPEND BUT FOR THE DELTA COEFFICIENTS C. C. - THE INPUT NUMBER OF COEFFICIENTS FOR ALPHA AND DELTA-NCGF C. C-TO BE SCLVED FOR (MUST BE GE 1 AND LE 4) C. MAXIT - THE INPUT MAXIMUM NUMBER OF CORRECTION ITERATIONS TO C. . C • BE PERFCRIVED C. CCEF C. - AN CUTPUT ARRAY CONTAINING THE STATE COVARIANCE C. AND CCRRELATION ELEMENTS FOR THE FINAL SOLUTION. CORRELATION ELEMENTS ARE IN THE UPPER TRIANGLE. C. C. COVARIANCE ELEMENTS ARE IN THE LOWER TRIANGLE. C. CIAGONAL ELEMENTS ARE COVARIANCE ELEMENTS.

```
- THE INPUT LEVEL OF INFORMATIVE PRINTOUT DESIRED:
         INRI
C.
                     >= 1 - PRINTOUT ERROR MESSAGE IF PROCESS ABNORMAL-.
C.
C.
                             LY TERMINATES
                     >= 2 - PRINTOUT ALL INPUT SCALERS AND INITIAL
Ç.
                             STATE ESTIMATES AND BOUNDS
C.
                     >= 3 - PRINTOUT THE INPUT POINTER ARRAYS:
C.
                             IFRS11, NTYPE1, IFRS12, NTYPE2
C .
                     >= 4 - PRINTOUT FINAL STATE, COVARIANCE ELEMENTS
C.
                             AND RESIDUALS AT END OF PROCESS
C-
                     >= 6 - PRINTOUT SAME INFORMATION AS 4 ABOVE, BUT
C.
                             AT THE END OF EACH ITERATION
C.
                     >= 8 - PRINTOLT ALL INPUT DATA ARRAYS
C.
                     >=10 - PRINTOUT CCEFFICIENTS OF MATRIX EQUATION
C.
                             AT EACH ITERATION
C.
                     >=12 - PRINTOLT INTERMEDIATE VALUES DURING SUMMA-
C.
                             TION STAGE OF EACH ITERATION
C.
                     >=14 - PRINTOUT ACCITIONAL INTERMEDIATE VALUES
C.
                             DURING SUMMATION FOR DIHECRAL ANGLE DATA
C.
Ĺ.
                - THE INPUT LOGICAL FORTRAN DEVICE NUMBER FOR SPECIFIED.
         ICUT
                  PRINTOUT (NERMALLY = 6)
C.
         IRET
                - RETURN INCICATOR:
                     = 0 - PRCCESS CONVERGED
C.
                     = 1 - PROCESS TERMINATED DUE TO MAXIMUM ITERATIONS.
С.
                            REACHED (MAXIT)
С.
                       2 - PRCCESS DIVERGED. I.E. A CORRECTION ELEMENT .
С.
                            EXCEEDED 360.0
۲.
                     = 3 - A SINGULAR MATRIX WAS ENCOUNTERED. - PROCESS .
C .
С.
                            COLLO NOT CENTINUE
                     = 4 - CVER 5 BIASES WERE SELECTED TO BE CETERMINED.
С.
                     = 5 - NCCF IS CUTSIDE ALLOWABLE RANGE
С.
                     = 6 - ALL DATA IS WEIGHTED 0.0
C.
С.
         ISMULT - THE MULTIPLE OF THE AVERAGE RESIDUAL TO BE USED IN
ũ.
                  RESIDUAL EDITTING
C.
C.
         TIMEL - AN INPUT ARRAY CONTAINING THE OBSERVATION TIMES FOR
Ć.
                  CLASS 1 DATA (UNITS MUST BE CONSISTENT WITH TIME2.
€.
                  TZERC, ALP, DEL)
Ç.
€.
         AXIS1 - A THO DIMENSIONAL INPUT ARRAY - AXIS1(3,N) - CONTAIN-.
C.
C.
                   ING THE INERTIAL UNITIZED CONE AXIS VECTORS FOR CLASS.
                   1 DATA
C .
C.
                - AN INPUT ARRAY CONTAINING THE CONE GENERATING ANGLES
C.
         ANG1
                   (IN DEGREES) IN THE RANGE 0-180 FOR CLASS 1 DATA
C.
0.
         WGHT1 - AN INPUT ARRAY CONTAINING THE WEIGHTS TO BE APPLIED
C.
                  TO THE OBSERVATIONS OF CLASS 1 DATA (NORMALLY THE
C.
Ç.
                   INVERSE VARIANCES IN DEGREES!
C.
         IFRST1 - AN INPUT ARRAY OF POINTERS INDICATING THE START POSI-.
C.
                  TIONS OF EACH TYPE OF CLASS 1 DATA WITHIN THE ARRAYS .
Ć.
                  TIME1, AXISI, ANGI, WGHT1. THUS THE FIRST ELEMENT OF .
C.
C.
                   IFRST1 IS THE INDEX NUMBER OF THE FIRST OBSERVATION
                  OF THE FIRST TYPE OF CLASS 1 DATA WITHIN THE ARRAYS
C.
                   TIMEL,..., WGHTL. THE SECOND ELEMENT OF IFRST1 IS
C.
                   THE INDEX NUMBER OF THE FIRST OBSERVATION OF THE SEC-.
C.
                  END TYPE OF CLASS I CATA WITHIN THE ARRAYS TIMEL,...,.
C.
                  WGHT1. ETC.
С.
```

C. С. C. C. ٥. С. C. C. C. C. С. C. C. C. C . Ci C. С. C . C. C. C. €. Ca C. C C. Cá C. C. C. С. С. C . C. C.

£.

- NTYPEL AN INPUT ARRAY CONTAINING OBSERVATION COUNTS, ONE FOR-EACH TYPE OF CLASS 1 DATA (=NCLAS1). THE VALUE OF EACH ELEMENT IS THE NUMBER OF OBSERVATIONS OF THAT TYPE IN THE DATA ARRAYS TIME1, AXIS1, ANG1, WGHT1
- BIAS1 AN INPUT ARRAY CONTAINING INITIAL ESTIMATES OF BIAS
 IN DEGREES, ONE FOR EACH TYPE OF CLASS 1 DATA
 (=NCLAS1). IF THE VALUE OF AN ELEMENT IS =9599999..
 BIAS IS NOT DETERMINED FOR THAT TYPE. IF IT IS NOT .
 =9959595.. EIAS IS DETERMINED AND THE FINAL DETERMIN—.
 ED VALUE IS RETURNED IN THE SAME ELEMENT. NO MORE
 THAN 5 PIASES IN TOTAL FROM CLASS 1 DATA AND CLASS 2.
 CATA MAY BE DETERMINED
- PENDI AN INPUT ARRAY CONTAINING THE LOWER BOUNDS IN DEGREES.

 FOR CORRECTION TO THE ASSOCIATED BIAS ELEMENTS FOR EACH TYPE OF CLASS 1 DATA (=NCLAS1). IF THE ASSOCHIATED BIAS ELEMENT =9999999.0, THE BBND1 ELEMENT IS NOT USEC
- RHCST1 A TWO DIMENSIONAL OUTPUT ARRAY RHOST1(3,N) IN
 WHICH FINAL RESIDUAL STATISTICS FOR EACH GATA TYPE
 ARE RETURNED:
 (1,N) = WEIGHTED SUM OF ANGLE RESIDUALS
 (2,N) = WEIGHTED SUM OF SQUARES OF ANGLE RESIDUALS
 (3,N) = SUM OF WEIGHTS
- NCLAS1 THE NUMBER OF TYPES OF CLASS 1 DATA IN THE ARRAYS TIME1, AXIS1, ANG1, WGHT1, IFRST1, NTYPE1, BIAS1, BBNC1, RHOST1
- RHO1 AN CUTPLE ARRAY CONTAINING THE ANGLE RESIDUALS FOR ALL TYPES OF CLASS 1 DATA
- RESID1 AN CUIPLT ARRAY CONTAINING THE MEAN RESIDUAL FOR EACH TYPE OF CLASS 1.DATA
- STEV1 AN CUTPUT ARRAY CONTAINING THE STANDARD DEVIATION FOR EACH TYPE OF CLASS 1 DATA
- TIME2 SAME AS TIME! BUT FOR CLASS 2 DATA
- AXIS2 A TWO DIMENSIONAL INPUT ARRAY AXIS2(6,N) CONTAIN-.
 ING THE TWO ORDERED, UNITIZED VECTORS FOR EACH DIHED-.
 RAL ANGLE OPSERVATION; I.E. THE FIRST VECTOR IS IN
 (1,N),(2,N),(3,N) AND THE SECOND VECTOR IS IN (4,N),
 (5,N),(6,N)
- ANG2 AN INPUT ARRAY CONTAINING THE DIHEDRAL ANGLES (IN DEGREES) IN THE RANGE 0-360 FOR CLASS 2 DATA
- WGFT2 SAME AS WGHTL BUT FOR CLASS 2 DATA
- IFRST2 SAME AS IFRST1 BUT FCR CLASS 2 DATA
- NTYPE2 SAME AS NTYFEL BUT FOR CLASS 2 DATA
- BIASE SAME AS BIASE BUT FOR CLASS 2 DATA

```
€.
        EBND2 - SAME AS BENC1 BUT FOR CLASS 2 DATA
€.
C.
         RHCST2 - SAME AS RHOSTI BUT FCR CLASS 2 DATA
Ċ.
C-
        NCLASZ - SAME AS NCLASI BUT FCR CLASS 2 DATA
С.
C.
        REC2 - SAME AS REG1 BUT FOR CLASS 2 DATA
C.
C.
         RESIEZ - SAME AS RESIDI BUT FOR CLASS 2 DATA
Ç.
€.
         STEV2 - SAME AS STEVI BUT FOR CLASS 2 DATA
Ç.
C.
         TRESID - COMBINED TOTAL MEAN RESIDUAL (DEGREES)
C.
C.
         ISTOV - COMBINED TOTAL STANDARO DEVIATION (DEGREES)
С.
C.
C.
     CPTICNS:
C.
C.
         A. DYNAMIC ATTITUDE MAY BE SPECIFIED WHERE ALPHA AND DELTA ARE.
C.
            TIME DEPENDENT POLYNOMIALS (UP TO 3RD DEGREE) AND THE
C.
            CCEFFICIENTS ARE SOLVED FOR AS THE STATE VARIABLES. WHEN
С.
            USING THIS CPTION, THE ALP AND DEL ARRAYS REPRESENT THE
C.
            CCEFFICIENTS: AC, A1, A2, A3, DO, D1, D2, D3, RESPECTIVELY, OF
C.
            THE FOLLOWING EXPRESSIONS:
C.
C.
               A(T) = AO + A1 + (T-TZERO) + A2 + (T-TZERO) + 2
C.
                      A3*(T-T/ER0)**3
€.
               O(T) = OC + C1*(T-TZERO) + D2*(T-TZERO)**2 +
                      03*(T-TZERO)**3
C.
С.
         E. EACH CLASS OF DATA, CLASS 1 - CONE ANGLE AND CLASS 2 -
            DIHEDRAL ANGLE, MAY EACH BE COMPOSED OF ANY NUMBER OF
C.
            TYPES OF DATA, I.E. NCLASI AND NCLASZ MAY BE ANY NON-NEG-
C.
            ATIVE NUMBERS JUST SO LONG AS THERE ARE NOLASI ENTRIES IN
C.
            THE IFRST1 AND ATYPEL ARRAYS AND NOLASE ENTRIES IN THE
С.
            IFRST2 AND NTYPEZ ARRAYS
C.
С.
         C. WITHIN THE INPUT GATA ARRAYS, UNDESIRED CBSERVATIONS CAN
C.
            BE FLAGGED BY SETTING THE CBSERVATION TIME =9999999.
C.
            SUCH COSERVATIONS WILL BE COMPLETELY IGNORED
C.
C.
         C. UP TO 5 CONE AND/CR DIHEDRAL ANGLE BIASES MAY BE SOLVED
C.
            FCR IN ANY COMBINATION WITHIN THE VARIOUS CATA TYPES AND
C
CI
            CLASSES
C.
         E. ANY NUMBER OF DATA OBSÉRVATIONS MAY BE PRESENT WITHIN ANY
С.
            TYPE OF CATA AND ANY NUMBER OF TYPES MAY BE SPECIFIED
C
            WITHIN EITHER CLASS
Ç.
Ç.
         F. A FULL RANGE OF INFORMATIVE PRINTOUTS MAY BE SPECIFIED
C
            BY THE INPUT PARAMETER INRT
¢.
С.
C.
     RESTRICTIONS:
Ç.
C 🕹
         A. NCOF MUST BE GREATER THAN ER EQUAL TO 1 AND LESS THAN OR
C.
```

EQUAL TO 4

- 8. CEEF MUST BE CIMENSIONED LARGE ENOUGH TO CONTAIN ALL COVARIANCE AND COFRELATION ELEMENTS. IT SHOULD BE DIMENSIONED COEF(N,N) WHERE N = 2*NCOF + NUMBER OF BIASES TO BE DETERMINED
- C. AXISI AND AXIS2 MUST CONTAIN THE INERTIAL COORDINATES OF UNITIZED VECTORS
- E. THE ANGLES IN THE ANG2 ARRAY MUST BE RANGED FROM C TO 360 DEGREES
- E. THE VECTOR PAIRS IN THE AXIS2 ARRAY MUST BE CROERED, I.E. THE DIHEDRAL ANGLE IS MEASURED FROM THE PROJECTION OF THE FIRST VECTOR ENTO A PLANE NORMAL TO THE SPIN AXIS, AROUND TO THE PROJECTION OF THE SECOND VECTOR ONTO THIS FLANE, POSITIVE IN THE SENSE OF POSITIVE ROTATION ABOUT THE SPIN AXIS.
- F. THE UNITS OF TIME IN THE INPUT QUANTITIES TIME1, TIME2,
 TZERO, ALP, DEL MAY BE ARBITRARY BUT MUST BE CONSISTENT
 (THE SAME). THE UNITS SHOULD, HOWEVER, BE SELECTED SO THATTHE MAXIMUM EXPECTED STATE CORRECTIONS NEVER EXCEED 360.0,
 WHICH IS DEFINED AS DIVERGENCE
- C. DIHEDRAL ANGLE (CLASS 2) CESERVATIONS WHICH DIFFER FROM THE COMPUTED DIHEDRAL ANGLE BASED ON THE CURRENT STATE BY MORE . THAN 90.0 DEGREES WILL BE IGNORED (WEIGHTED TO ZERO) FOR . THAT ITERATION .

SUBROUTINES CALLED:

C.

C.

C.

С.

C.

C.

C.

C .

C.

C.

C.

C. C.

C.

C.

C.

C .

С.

C. C.

C.

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C.

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C.

C.

C. C....

C.

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C.

C.

- A. COFSUM COEFFICIENT SUMMATION. THIS IS A SPECIALIZED ROUT-INE USED DNLY BY GCONES TO COMPUTE AND SUM THE ELEMENTS OF THE MATRIX TO BE INVERTED FOR EACH ITERATION.
- E. MINV MATRIX INVERSION. THIS IS AN IBM ROUTINE FROM THE SCIENTIFIC SUBROUTINE PACKAGE (SSP)

INPUT/CUTPUT CATA SETS

- A. READ CNLY NENE
- 8. READ AND WRITE NONE
- C. WRITE ONLY FTXXFOG1 (XX IS SPECIFIED BY 10UT) CENTAINS INFORMATIVE PRINTOUT SPECIFIED BY IWRT

REMARKS:

A. IF ONLY ONE CLASS OF DATA IS TO BE INPUT, THE ARGUMENTS FOR THE UNUSED CLASS MAY BE UNDIMENSIONED DUMMY VARIABLES JUST SO LONG AS NOLAS? (OR NOLAS?) IS SET TO O

- E. IF BIAS IS NOT TO BE CETERMINED FOR A CERTAIN TYPE OF DATA+.
 THE ASSOCIATED VALUE IN THE BIASI OR BIAS2 ARRAY SHOULD BE .
 EQUAL TO 999999.
- C. THE QUANTITIES RETURNED IN THE RHOST1 AND RHCST2 ARRAYS MAY BE USED TO COMPUTE THE MEAN DEVIATION AND STANDARD DEVIATION OF FIT FOR EACH TYPE OF DATA
- C. CCNVERGENCE IS REACHED ONLY WHEN ALL STATE VARIABLE CORRECTIONS ARE SIMULTANEOUSLY LESS THAN THEIR CORRESPONDING BOUNDS, INCLUDING BIAS ELEMENTS
- E. IF DATA OBSERVATIONS ARE SCREENED PRIOR TO INPUT TO GCONES... UNWANTED OBSERVATIONS MAY BE FLAGGED BY SETTING THE ASSOC... IATED TIME =9595959.
- F. THE ALP AND DEL AFRAYS CONTAIN COEFFICIENTS OF POLYNOMIALS .
 AND ARE NOT, STRICTLY SPEAKING, ACCELERATION AND JERK (RATEOF CHANGE OF ACCELERATION) AS THEY ARE FOR SOME OTHER
 MODELS

REFERENCES:

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- A. L.B. SCHLEGEL, "CONES: AN ITERATIVE DIFFERENTIAL CORRECTION.
 TECHNIQUE FOR ATTITUDE DETERMINATION OF A SPINNING SATEL—
 LITE", IBM FSC REFORT, CONTRACT NAS 5-10022, MAY 1967
 .
- B. "SURVEY AND EVALUATION OF ATTITUDE DETERMINATION TECHNIQUES", IBM FSC REPORT TR-68-8, CONTRACT NAS 5-10022, MAY 1968, PP. 4-14 TO 4-24
- C. "RADIO ASTRONOMY EXPLORER ATTITUDE DETERMINATION SYSTEM (RAEACS), VCL III, SPIN AXIS ATTITUDE DETERMINATION PROGRAM. —CYCON", IBM FSC REPORT, CONTRACT NAS 5-10022, MARCH 1969
- C. "SYSTEM/360 SCIENTIFIC SUBROUTINE PACKAGE, VERSION II. PROGRAMMER'S MANUAL". IBM FORM NO. H20-0205-2

REVISIONS:

A. F. KNCCP (O1 AUG 1969) - CRIGINAL CODING AND TESTING

C-----

- E. F. KNCOP (2C JAN 1970) MCDIFICATION TO CHECK FOR DIVERG-ENCE TO PREVENT IFC254I ERRORS DUE TO ABSURDLY LARGE CORR-ECTION ELEMENTS
- C. F. KNCCP (2C JAN 1970) REORDERING OF ERROR RETURN CODES INTO CROER CF SEVERITY
- C. F. KNCCP (2C FEB 1970) CEMPLETE REVISION TO INCLUDE DIHEDRAL ANGLE CATA
- E. A. GEELHAAR (15 SEPT 1972) ADDITION OF SIGMA REJECTION CAPABILITY AND REVISION OF CALLING SEQUENCE

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SUBBOUTING OCCNES (IZERC. ALP. CEL. ALPBNO, DELBNO, NCOF, MAXIT,
           COEF, INRT, ICUT, IRET, ISMULT,
           TIMEL, AXISI, ANGI, NGHTI, IFRSTI, NTYPEL, BIASI, EBNDI.
           RHCST1.NCLAS1.RHC1.RESID1.STCV1.
           TIME2, AXIS2, ANC2, MGHT2, IFRST2, NTYPE2, BIAS2, BBND2,
           RHCST2.ACLAS2.PHC2.RESID2.STDV2.TRESID.TSTDV)
C
C
      DIMENSION ALP(4), DEL(4), ALPBNO(4), DELBND(4); COVAR(91)
 ***** DIMENSIONS EQUAL TO 5 OR 500 IN THE ECLLOWING LIST ARE NOT
 ***** RESTRICTIVE, BUT ARE MEANT ONLY TO BE SUGGESTIVE OF THE STRUC-
C **** TURE OF THE ARRAYS
      DIMENSION FIME1(500), AXIS1(3,500), ANGI(500), WGHTI(500),
                 IFRST1(5), NTYPE1(5), BIASI(5), BEND1(5), RECETI(3,5)
      DIMENSION TIME2(500), AXIS2(6,500), ANG2(500), WGHT2(500),
                 1FRST2(5), NTYPE2(5), BIAS2(5), BBND2(5), RHOST2(3,5)
C ***** INTERNALLY ALLOCATED SPECIFICATIONS
     DIMENSION ALPRIAL, CEERIAL, COEFILA, 13), CHNG(13), DRHOSQ(13),
           RHC1(500), RHC2(500), STCV1(5), RESID1(5), STCV2(5), RESID2(5),
                 STCR1(13), STCR2(13), CCF(169), AVGRHO(2,5), NAME(2,13)
      CATA RTCD. XBIAS / 57.29578,9959999./
      DATA NAMEZ' ALP', "HA 1', " DEL', "TA 1', " ALP', "HÀ 2', " DEL',
     / 'TA 2', ALP', 'HA 3', CEL', 'TA 3', ALP', 'HA 4', DEL',
/ 'TA 4', PI', 'AS 1', BI', 'AS 2', BI', 'AS 3', BI', 'AS 4',
         EI1 . 1AS 51/
 ***** PRINTCUL AT OPTION ALL THE INPUT VARIABLES AND DATA ARRAYS
      IF(IWRT.LT.2) GC TG 100
 **** WRITE HEADER LINE AND ALL INPUT NON-ARRAY ITEMS
      WRITE (IQUI, 8000) NCLASI, NCLAS2, TZERO, NCOF, MAXIT, İWRI, IQUI
  ***** KRITE INITIAL ATTITUDE COEFFICIENTS AND CORRECTION HOUNDS
      WRITE (IDUT, 8010) (ALP(1), ALPBNO(I), DEL(I), DELBNO(I), I=1, NCOF)
 **** WRITE INITIAL BIAS ESTIMATES AND CORRECTION BOUNDS
      IF(NCLAS1.LE.O) GC TG 3C
      ITITLE = 1
      DC 2C I = 1.NCLASI
                                                                            00018800
                                                                            00018900
      IF(BIASI(I).FC.XBIAS) GC TO 20
      IF(ITITLE.EG.1) WRITE (IDUT.8020)
                                                                            00019000
                                                                            00019100
      ITITLE = 2
      WRITE (ICUT, 8040) I, BLAST(I), BENC1(I)
                                                                            00019200
   20 CONTINUE
                                                                            00019300
                                                                            00019400
   30 CENTINUE
      TRINCLASZ.LE.O) GC TO 60
                                                                            00019500
      1111LE = 1
                                                                            00019600
      DC 50 I = 1.NCLAS2
                                                                            00019700
      IF(PIASZ(I).EC.XBIAS) GC TO 50
                                                                            00019800
      IF(ITITLE.EC.I) WRITE (IOUT.8030)
                                                                            00019900
      \{TITLE = 2
                                                                            00020000
      WRITE (IGUT, 8040) I, BIASZ(I), RENDZ(I)
                                                                            00020100
   50 CONTINUE
                                                                            00020200
   60 CONTINUE
                                                                            00020300
      TELLERIALT.3) GC TO 100
                                                                            00020400
      IF (NCLASI.LE.C) GC TO BC
                                                                            00020500
      DC 70 I = 1.NCLAS1
                                                                            00020700
      J1 = IFRST1(I)
                                                                            00020800
      N = NIYPEI(I)
                                                                            00020900
      J2 = J1 + N - 1
                                                                            00021000
      WRITE (1007,8050) I, N. JI, J2
                                                                            00021100
      TRITIART.GE. # .AND. N.GT.O) WRITE (1887,8670) (J. TIMELLJ).
                                                                            00021200
           (AxIS1(K,J),K=1,3), ANG1(J), WGHT1(J), J≈J1,J2)
                                                                            00021300
   70 CONTINUE
                                                                            00021400
   80 CONTINUE
                                                                            00021500
      IF(NCLAS2.LE.O) GC TC 100
                                                                            00021600
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00021800
      2C 9C I = 1.NCLA52
                                                                        . 00021900
      JI = IFRST2(I)
                                                                          00022000
     N = N(YPEZ(1))
                                                                          00022100
      J2 = J1 + N - 1
                                                                          00022200
      WRITE (10UT, 8060) I, N, JI, J2
      IFILINAT.GE.E .AND. N.GT.O) WRITE (1001,8080) (J. TIME2(J).
                                                                          00022300
                                                                          00022400
          [AXIS2[K,J),K=1,6], ANG2(J), WGHT2(J), J=J1,J2)
                                                                          00022500
   90 CONTINUE
                                                                          00022600
  100 CONTINUE
C **** CEMPUTE THE NUMBER OF ANGLE BLASES TO BE DETERMINED
                                                                          00022700
                                                                          00022800
      NBIAS = 0
                                                                          00022900
      TEINCLASI.LE.C) GC TU 120
                                                                          00023100
      CC 110 I = 1.NCLAS1
      IF(PIASITI).NE.XBIAS) NEIAS = NBIAS + 1
                                                                          00023200
                                                                          00023300
  110 CONTINUE
                                                                          00023400
  120 CENTINUE
                                                                          00023500
      IF (NCLAS2.LE.C) GC TG 140
                                                                          00023700
      DC 13C I = 1.NGLASZ
                                                                          00023800
      IF(PIAS2(I).NE.XBIAS) NEIAS = NBIAS + 1
                                                                          00023900
  140 CENTINUE
                                                                          00024000
  140 CENTINUE
                                                                          00024100
C **** CHECK FOR INVALID INPLT
                                                                          00024200
      IF(NCCF.LT.) .CR. NCOF.CT.4) GC TC 7000
                                                                          00024300
      IF(NBIAS.GT.5) CO TC 7010
                                                                          00024400
C ** ** CEMPUTE SEME CONSTANTS FOR THE SUMMATION
                                                                           00024500
      N2 = ACCF + ACCF
                                                                           00024600
      N3 = N2 + NBIAS
                                                                           00024700
      N4 = N2 + 1
                                                                           00024800
      N5 = N3 + 1
                                                                           00024900
      181 = 9
                                                                           00025000
      182 = 181 + N81A5 + 1
                                                                           00025100
      LC 150 J=1.N3
                                                                           00025200
      0.0=(L)0/HD
                                                                           00025300
  150 CONTINUE
                                                                           00035100
C ***** INTITALIZE ITERATION COUNTER
                                                                           00035200
      ISTEF = 0
                                                                           00035300
C ***** INITIALIZE TERMINATION CONTROL
                                                                           00035400
      15109 = 0
                                                                           00035500
                                                                           00035600
  ***** BEGIN PROCESSING FOR THIS ITERATION
€.
                                                                           00035700
                                                                           00035800
  200 CONTINUE
                                                                           00035900
      ISTEP = ISTEP + 1
                                                                           00036000
C ***** CCNVERT ATTITUDE CCEFFICIENTS TO RADIANS
                                                                           00036100
      DC 210 i = 1,NCCF
                                                                           00036200
       ALPR(I) = ALP(I)/RTCO
                                                                           00036300
      DELR(1) = DEL(1)/RICD
                                                                           00036400
   210 CONTINUE
                                                                           00036500
C ***** ZERC CUT MATRIX OF COEFFICIENTS
                                                                           00036600
      DC 236 I =1,N3
DC 226 J =1,N3
                                                                           00036700
                                                                           00036800
       CCEF(J,I) = C.C
                                                                           00036900
   220 CONTINUE
                                                                           00037000
       DRHCSC(I) = 0.0
                                                                           00037100
   230 CCNTINUE
                                                                           00037200
       TPIAS = N2
                                                                           00037300
  ***** PEGIN LOOP TO MAKE ALL SUMMATIONS FOR CLASS 1 DATA (CONE ANGLES)00037400
                                                                           00037500
                                                                           00037600
       [FINCLASI.LE.O] GC TU 3CO
                                                                           00037800
       DC 290 I = 1.NCLAS1
                                                                           00037900
       JI = IFFSTI(I)
                                                                           00038000
       \Lambda = NTYPEL(I)
                                                                           00038200
 C ***** ZERC CUT RESIDUAL SUMMATION VARIABLES
                                                                           00038300
       RECSII(I,I) = C.C
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RHC511(2.1) = .0.0
                                                                         00038400
      RHOST1(3.1) = 0.0
                                                                         00038500
      IFINALEACT OF TE 29C
                                                                         00038100
      IF(BIASI(I).NE.XRIAS) IEIAS = IPIAS + 1
                                                                         00038600
C ***** CALL COFSUM TO COMPUTE AND SUM COEFFICIENTS FOR THIS TYPE OF
                                                                         00038700
C **** CLASS 1 DATA
                                                                         nonassoo
                        CALL CGFSUM (TIME1(J1), AXIS1(1,J1), ANG1(J1), WGHT1(J1), N, 1, 3,00039000
                  ALPR. DELR. BIASI(1), IBIAS, NCCF. TZERC: INRT. IDUT. 00039100
                  CCEF, CRFCSQ, RHOSTÍ(1, I), AVGRHO(1, I), RHCI(J1))
                                                                       ..00039300
  290 CONTINUE
                                                                         00039400
  300 CONTINUE
                                                                         00039500
r.
                                                                        00039600
 ***** BEGIN LOOP TO MAKE ALL SUMMATIONS FOR CLASS 2 DATA (DEED ANGLES)COD39700
                                                                         00039800
      IF (NCLASSILE.C) GC TO 400
                                                                         00039900
     DE 390 I = 1.NCLAS2
                                                                         00040100
      JI = IFRST2(I)
                                                                         00040200
      N = NTYPE2(1)
                                                                         00040300
C **** ZERC CUT RESICUAL SUMMATION VARIABLES
                                                                         00040500
      RHOS12(1.1) = 0.0
                                                                         00040600
      RECST2(2,I) = 0.0
                                                                         00040700
      RECST2{3,I} = 0.0
                                                                         00040800
      IFIN.LE.O) GC TC 39C
                                                                         00040400
      IF(PIAS2(I).NE.XBIAS) LEIAS = IBIAS + 1
                                                                         00040900
C ***** CALL COFSUM TO COMPUTE AND SUM COEFFICIENTS FOR THIS TYPE OF
                                                                        00041000
C **** CLASS 2 DATA
                                                                         00041100
                                                                      ...00041260
     CALL COFSUM (TIME2(JE), AXIS2(1,J1), ANG2(J1), WGHT2(J1), N, 2, 6,00041300
                  ALPR. DELR. BIAS2(1). IBIAS. NCCF. TZERG. IWRT. IOUT. COC41400
                  CCEF, CRHOSQ, RHOST2(1,1), AVGRHO(2,1), RHCZ(J1))
                                                                        .00041600
 390 CENTINUE
                                                                         00041700
  400 CONTINUE
                                                                         00041800
C. ***** CCFSMS COMPLIES ONLY CIAGENAL AND UPPER RIGHT CFF-DIAGENAL
                                                                         00041900
C ***** ELEMENTS OF THE COEFFICIENT MATRIX BECAUSE IT IS A SYMMETRIC
                                                                         00042000
C **** MATRIX
                                                                         00042100
C ***** COMPLETE LOWER LEFT OFF-DIAGONAL ELEMENTS OF SYMMETRIC MATRIX
                                                                         00042200
     DE 480 I = 2.N3
                                                                         00042300
     N = I - 1
                                                                         00042400
      DC 480 J = I+N
                                                                         00042500
     CCEF(I,J) = CCEF(J,I)
                                                                         00042600
  480 CENTINUE
                                                                         00042700
      IF([WRT.LT.10] GO TC 540
                                                                         00042800
C **** WRITE COEFFICIENTS OF SIMULTANEOUS EQUATIONS
                                                                         00042900
     WRITE (IGUT, 8100)
                                                                         00043000
      00 520 I = 1.83
                                                                         00043100
      WRITE (IOUT, 0120) (CCEF(I,J), J=1,N3), CRHOSC(I)
                                                                         00043200
  520 CENTINUÉ
                                                                         00043300
  540 CONTINUE
                                                                         00043400
C ***** RESTRUCTURE CLEF MATRIX TO FORMAT EXPECTED BY IBM SSP - MINV
                                                                         00043500
                                                                         00043600
      DC 545 I = 1.N3
                                                                         00043700
      00.545 J = 1.N3
                                                                         00043800
      K = K + 1.
                                                                         00043900
      CCF(K)=CCEF(J,I)
  545 CONTINUE
                                                                         00044100
C **** CALL IBM SSP ROLTING MINV TO INVERT COEF MATRIX
                                                                         00044200
      CALL MINVICER, N3, DET, STER1, STER2)
                                                                        .00044500
      IF(EET.EG.O.C) GG TC 7020
                                                                         00044600
C ***** CALCULATE CORRELATION MATRIX, COMBINE WITH COVARIANCE MATRIX
     K = C
      CC 550 i=1+N3 -
```

```
OC 550 J≃1.N3
     K = K + 1
 550 CCEF(J, T)=CCF(K)
      13F1=13-1
      OC 555 I=1.N3M1
      11=1+1
     UC 555 J=11,N3
      T=CCEF(I,I)*CCEF(J,J)
      IF(1.LE.C.C) CC TO 554
      CCEF(1,3)=CCEF(1,J)/SCRT(1)
      GE 10 555
 554 CCEF(1,J)=999.
  555 CONTINUE
C **** MULTIFLY CEVARIANCE MATRIX BY VECTOR OF RHO
C ***** SCLARCE GERIVATIVES TE CHTAIN ATTITUDE STATE CORRECTIONS
                                                                         00044800
                                                                         00044900
      K = C
                                                                         00045000
      LC 560 I = 1.83
                                                                         00045100
      CFNC(I) = 0.0
      DC 560 J = 1,N3
                                                                         00045200
                                                                         00045300
      K = K+1
      CHNC(I)=CHNG(I)+CCF(K)*ERFOSC(J)
                                                                         00045500
  560 CUNTINUE
      IF(ISTOP.NE.C) CE TO 610
                                                                         00045600
C **** SET INDICATOR TO "CONVERGED"
                                                                          00045700
      IPET = C
                                                                         00045860
                                                                         00045900
     DC &CC I = 1,NCCF
C **** CHECK FOR NON-CONVERGENCE
                                                                         00046000
      IF(\Delta ES(CHNC(2*I-1)).GT.ALPBND(I)) [RET = 1
                                                                         00046100
                                                                          00046200
      [F(ARS(CHNG(2*I)) .GI.CELRAC(I))] IRET = 1
C **** CHECK FOR DIVERGENCE
                                                                         C0046300
      IF(AES(CHNG(2*I-1)).GT.360.0) GC TO 7030
                                                                         C0046400
      IF(ABSIGHNG(2*11) .GT.36C.C) GC TO 7030
                                                                          00046500
                                                                          00046600
  600 CONTINUE
C ***** CHECK FOR DIVERGENCE OF BIAS ELEMENTS
                                                                          00046700
                                                                          00046800
      IF(NBIAS-LE-C) GO TC &CE
                                                                          00046900
      K = N2
      IFINCLASI.LE.C) GC FO 6C4
                                                                          00047000
                                                                          00047200
      DC 6C2 I = 1.NCLAS1
                                                                          00047300
      IF(814S1(1).EQ.X81AS) GC TO 6C2
                                                                          00047400
      K = K + 1
                                                                          00047500
      IF(AES(CHNG(K)).GT.EBND1(I)) IRET = 1
                                                                          00047600
      IF(ABS(CHNG(K)).GT.36C.C) GC TC 7C30
                                                                          00047700
  602 CONTINUE
                                                                          C0047800
  604 CONTINUE
                                                                          00047900
      IFINCLAS2.LE.O) GC TO 608
                                                                          00048100
      UP 606 I = 1.00LAS2
                                                                          00048200
     IF(PIASZ(I)_EQ_XBIAS) GC TO 606
                                                                          00048300
      K = K + 1
      IF(ABS(CHNG(Y)).GT.BBND2(I)) IRET = 1
                                                                          00048400
                                                                          00048500
      IF(ABS(CHNC(K)).GT.36C.C) GC TO 7030
                                                                          00048600
  606 CCATIAUE
                                                                          00048700
  ECB CENTINUE
  610 CENTINUE
                                                                          00048800
      IX = C
      IF(INRT.LT.4.CR.(IWRT.LT.c.AND.ISTOP.EQ.O)) IX=1
      IF(IX-NE-C) CC TC 625
C ***** WRITE COMBINED COVARIANCE - CERRELATION MATRIX
      IF(NBIAS.LE.O) hRITE (ICUT.8250) (NAME(1.1), NAME(2,1), I=1,N2)
                                                                          00049200
      IF(NBIAS.GT.C) WRITE (ICUT.8250) (NAME(1,1), NAME(2,1), 1=1,N2),
                                                                          00049300
                        (NAME(1,1), NAME(2,1), 1=181,182)
                                                                          00049400
                                                                          00049600
      DC 620 I = 1.83
                                                                          00049700
      II = I
                                                                          00049800
      15(1.67.N2) 11 = 1 - N2 + 8
      WRITE(ILUT, 9260) NAME(1, 11), NAME(2, 11), (COEF(J, 1), J=1, N3)
                                                                          00050100
  620 CONTINUE
                                                                          00050200
```

```
C **** CCMPUTE AND PRINTCUT STATISTICS OF RESIDUALS
                                                                           00050300
                                                                           00050400
                                                                           00050500
 ***** STATISTICS FOR CLASS I TYPES
r
  625 WT1≈6.0
                                                                           00050700
      STAT = C.O
      SIPI = C.0
                                                                           00050800
                                                                           00050900
      IF(NCLASI.LE.C) GC TO 640
                                                                           00051000
      ITITLE = 1
                                                                           00051100
      DC 630 I = 1.NULAS1
      RESILI(I)=0.C
      STUVICID=C.C
                                                                           00051200
      k = REOSTI(3,I)
                                                                           00051300
      IF(W.LE.C.C) GC TC 63G
                                                                           00051400
      SI = RHCST1(1.1)/W
      S2=SGRT(AMAX1(0., RHCST1(2,1)/k-S1*S1))
      IF(IX.EC.G.AND.ITITLE.EC.1) WRITE(IDUT.8270)
      RESIDILIDEST
      STOVI(I)=S2
                                                                           00051700
      ITITLE = 2
      IF(IX.EQ.0) WRITE(IDLT.8290) 1.51.52.W
      wT1 = wT1 + w
                                                                           00051900
      STA1 = STA1 + RHOST1(1,1)
STR1 = STB1 + RHOST1(2,1)
                                                                           00052000
                                                                           00052100
                                                                           00052200
  630 CONTINUE
                                                                           00052300
      1F(WT1.LE.O.C) GO TC 64C
      S1 = STA1/kT1
                                                                           00052400
      S2=SCRT(AMAX1(0.,ST81/W11-S1*S1))
      IF(IX.EQ.O) WRITE(ICUT, 8295) SI,S2,WT1
  640 CONTINUE
                                                                           00000100
                                                                           00000200
C **** STATISTICS FOR CLASS 2 TYPES
     - kT2 = 3.0
                                                                           00000300
      STA2 = C.0
                                                                           00000400
      5182 = C.C
                                                                           00000500
      IF (NCLAS2.LE.C) GC TU 658
                                                                           000000600
                                                                           0.00000700
      ITITLE = 1
      UC 650 L = 1.NCLAS2
                                                                           00000800
      RESIC2(1)=0.0
      SICV2(I)=0.0
      W = REOST2(3,1)
                                                                           00000900
     IF ( W.LE. U. O) GL TC 450
                                                                           00001000
      S1 * RHCST2(1.1)/W
                                                                           00001100
      $2=$CRT(AMAX1(0.,RHC$12(2,1)/w-$1*$1))
      IF([x.eq.c.ANG_ITITLE.Eq.1) WRITE([CUT,8280]
      RESIC2(1)=S1
      STDV2(1)=52
                                                                           00001400
      ITITLE = 2
      IF([X.EC.0) WRITE([OUT,8290] 1,51,52,W
      k12 = W12 + W
                                                                           00001600
      STA2 = STA2 + RHOST2(1,1)
                                                                           00001700
                                                                           00001800
      ST82 = ST82 + RFGST2(2,1)
                                                                            00001900
  650 CCNTINUE
      IF(WT2.LE.C.C) GC TO 658
                                                                           00002000
      S1 = STA2/WT2
                                                                           00002100
      $2=$GRT(AMAX1(0.,$T82/612-$1*$1))
      IF(IX.EC.O) WRITE(ICUT, 8295) S1, S2, WT2
  658 CONTINUE
                                                                            00002400
C **** COMBINED TOTAL STATISTICS
                                                                           00002500
      TRESID=0.0
      TSTEV=0.0
                                                                            00002700
      W = hT1 + hT2
      IF(W.EG.O.O) GC TO 7040
      S1 = (STA1+SFA2)/W
                                                                            00002800
      S2=SCRT(AMAX1(C.,(STB1+STB2)/W-S1*S1))
      IF(IX.EC.0) WRITE(ICUT, 6298) S1, S2
      TRESID=S1
      TSTEV=SZ
```

```
00003100
 660 CONTINUE
C ***** IF PROCESS HAS ENDED JUMP OUT OF CORRECTION LOOP
                                                                          00003200
     IF(ISTOP.NE.C) GC TC 75CC
C **** CHECK IF PROCESS SHOULD TERMINATE NEXT TIME
                                                                          00003400
IF([REI.EC.C.CR. ISTEP.GE.MAXIT) ISTOP = 1
C ***** UPLATE ATTITUDE STATE
                                                                         00003500
                                                                          00003700
                                                                          00003800
      CC 7CC 1 = 1.NCCF
                                                                          00003900
      ALP(1) = ALP(1) + CHAG(2*I-1)
                                                                          00004000
      DEL(I) = DEL(I) + CFNG(2*I)
  300 CONTINUE
                                                                          00004200
      IF (NETAS.LE.C) GG TC 706
                                                                          00004300
      K = NZ
                                                                          00004400
      IFINCLASIALE.C) GC TO 704
                                                                          00004600
      DC 702 I = 1, NCLASI
                                                                          00004700
      IF(BIASITI).EC. XBIAS) GT TO 702
                                                                          00004800
      K = K + 1
                                                                          00004900
      BIASI(I) = BIASI(I) + CFNG(K)
                                                                          00005000
  702 CONTINUE
                                                                          00005100
  704 CONTINUE
                                                                          00005200
      IF (NCLAS2.LE.C) GC TO 7(8
                                                                          00005400
      DC 7C6 1 = 1,NCLAS2
                                                                          00005500
      IF(BIASZ(I).EC.XBIAS) GC TO 706
                                                                          00005600
      K = K + 1
                                                                          00005700
      BIAS2(I) = BIAS2(I) + CFNG(K)
                                                                          00005800
  706 CENTINUE
                                                                          00005900
  708 CONTINUE
                                                                          00006000
      IFIIWRT.LT.4) GC TO 8CC
                                                                          00006100
      IF(ISTOP.EC.C) GC TC 71C
C **** WRITE PROCESS TERMINATION MESSAGE
                                                                          00006200
                                                                          00006300
      IF(IRET.EQ.C) WRITE (IQUT,83CC)
      [F([RET.EG.1] WRITE ([OLT.8320]
                                                                          00006400
                                                                          00006500
  710 CONTINUE
      IF(INRT.LT.6 .AND. ISTOP.EQ.0) GC TO 800
                                                                          00006600
                                                                          00006700
C **** WRITE UPDATED ATTITUDE STATE
                                                                          00006800
      WRITE (JOUT, 820C) ISTEP
                                                                          00006900
      DC 726 1 = 1.NCCF
      ACLC = ALP(I) - CFNG(2*I-1)
                                                                          00007000
      DELE = CEL(1) - CHNG(2*1)
                                                                          00007100
      WRITE (1001,8220) ACLC. CHNG(2*1-1).ALP(1). COLD. CHNG(2*1).
                                                                          00007200
                                                                          00007300
          CELLI
                                                                          00007400
  720 CENTINUE
      IF(NDIAS.LE.O) GO TO 760
                                                                          00007500
                                                                          00007600
      K = N2
      IF(NCLASI.LE.O) GC TG 740
                                                                          00007700
                                                                          00007800
      ITITLE = 1
      DC 736 I = 1.NCLAS1
                                                                          00007900
      IF(PIASI(I).EC.XBIAS) GC TC 730
                                                                          00008000
                                                                          00008100
      K = K + 1
                                                                          00008200
      BCLC = BIASI(I) - CFNG(K)
      IF(ITITLE.EG.1) WRITE (IOLT,8230)
                                                                          00008300
                                                                          00008400
      WRITE (10UT, 8245) I, BCLD, CHNG(K), BIASI(I)
                                                                          00008500
  330 CONTINUE
                                                                          00008600
                                                                          00008700
  740 CONTINUE
      IF (NCLASZ.LE.C) GC TO 760
                                                                          00008800
                                                                          00008900
      ITITLE = 1
      DC 75C I = 1.NCLAS2
                                                                          00009000
      IF(EIAS2(I).EC.XEIAS) GC IO 750
                                                                          00009100
                                                                          00009200
      K = K + 1
                                                                          00009300
      BCLC = BIAS2(1) - CFNG(K)
      1F(ITITLE.EC.1) WRITE (10UT.8240)
                                                                          00009400
      ITITLE = 2
                                                                          00009500
      WRITE (ICUT, 8245) I, ECLD, CHNG(K), BIAS2(I)
                                                                          00009600
  750 CONTINUE
                                                                          00009700
  760 CENTINUE
                                                                          00009800
                                                                          00009900
  ECO CONTINUE
```

```
C 4#### WEIGHT OUT DATA WITH LARGE RESIDUALS, IF DESIRED
      IF(ISMULT.LE.C) GO TO 200
      WRITE(ICUT.8246) ISMULT
      N = C
      SLMAV=0.0
      IF(NCLASI.LE.O) GG TG 806
      DC PC5 J=1.NCLAS1
      IFINTYPELGJ).LE.C) GC TO 805
      IFIIhRT.GT.10) HRITE(IOLT.8247) J,AVGRHÓ(1.J)
      IFTAVGREC(1.J1.GT.988.) GO TC 8C5
      N = N + 1
      SLMAV=SLMAV+AVGRHC(1.J)
  805 CENTINUE
  806 LFINCLAS2.LE.OF GO TO F11
      DC 810 J=1,NCLAS2
      IF(KTYPS2(J):LE.O) GC TO 810
      IF(INRT.GT.10) WRITE(IDLT,8248) J.AVGRHO(2.J)
      IF(AVGRED(2,J).GT.958.) GO TC 810
      N = N + 1
      SUMAV=SUMAV+AVGRHC(2.J)
  EIG CONTINUS
  EII AVG=SUMAV/N
      IFIINRT.GT.10) WRITE([CCT.8249) AVG
      IF(NCLASI.LE.G) GD TC 517
      CC 816 (=1.NCLAS1
      IF(NIYPEL(I).LE.O) GC 10 '816'
      JI=IFRSTI(I)
      N=NTYPEl(1)+J1-1
      CC 815 J=J1.N
                                       WGHT1(J)=0.0 ·
      IF (AES (RHC1(J)) -GT. ISMULT *AVG)
  PIS CONTINUE
  816 CONTINUE
  ELT [F(NCLAS2.LE.C) GO TO 200
      DC 821 1=1+NCL4S2
      IFINTYPE2(1).LE.C) GE TO 821
      J1=IFRST2(1)
      N=NTYPE2(1)+J1-1
      A.16=1 088 00
      IF(APS(RHC2(J)).CT.ISMULT*AVG)
                                       kGHT2(J)=0.0
  620 CONTINUE
  821 CONTINUE
                                                                           00010000
      CE 16 200
                                                                           00010100
C **** PRECESS HAS TERMINATED
                                                                           00010300
                                                                           00011600
C
                                                                           CC011700
C **** ERROR RETURNS
                                                                           00011800
                                                                           00011900
 7CCO CENTINUE
                                                                           00015000
      IRET = 5
                                                                           00012100
      GC TC YEOD
                                                                           00012200
 7010 CONTINUE
                                                                           00012300
       19E1 = 4
                                                                           00012400
      SC TC 7800
                                                                           00012500
 17020 CONTINUE
                                                                           00012600
      IREI = 3
                                                                           00012700
      GC 1C 7800
                                                                           00012800
 7030 CONTINUE
                                                                           00012900
      IRET = 2
      SC TC 7800
 7040 CONTINUE
       1RET=6
                                                                           00013000
 7EOO CUNTINUE
       IF (INREGEAL) WRITE (IDLE, 8999) IRET
                                                                           00013100
```

```
00013200
 7900 CONTINUE
                                                                            00013300
      IF(IMRT.GE.2) WRITE (IOUT.8340)
                                                                            00013400
      RETURN
                                                                            00013500
C
 00013700
 8CCO FCRMAT (1X, //, 1X, 44('-'), 1 SPECIFIED UNITHOUT FROM SUBROUTINE GCOGO13800 /CNES ',45('-'), /, 1X, 1 NCLAS1 NCLAS2 TZERC NCCF MAXOGO13900
                                                                            00014000
            INRT [CLT*, /, 1x, 218, F12.4, 418)
     /11
 PCIO FERMAT (1X, /, 1X, *INITIAL ATTITUDE COEFFICIENTS AND CORRECTION BC0014100 /OUNCS:*, /, 1X, * ALFHA(DEG) CORR BND(LEG) DELTA(DEG) CC00014200
     /RR PACICEGY, /: (1); F14.4, $16.6, $14.4, $16.6))
                                                                            00014300
 BC2G FCRMAT (1X, /, 1X, 4CLASS & (CONE ANGLE) INITIAL BIASES*, /,
                                                                            00014400
                                                                            00014500
     / 1x. TYPE
                          B[AS(LEG) CORR BNC(DEG)*)
 BC3C FORMAT (1x, /, 1x, *CLASS 2 (CHEC ANGLE) INITIAL BIASES*, /.
                                                                            00014600
                                                                            00014700
     / 1X, TYPE
                          BIAS(CEG) CORR BND(DEG) )
                                                                            00014800
 8040 FORMAT (1X. 14, F15.4, F16.4)
 ECSC FORMAT (1x. /. 1x, "CLASS I (CONE ANGLE) INPUT DATA TYPE", 12,
                                                                            00014900
           * FAS*, I4, * CBSERVATIONS, FROM*, I4, * TC*, I4, *, IN THE BOODISOOD
                                                                            00015100
     /ATA ARRAYS!)
 BCGC FORMAT (1x, /. 1x, "CLASS 2 (CHEC ANGLE) INPUT DATA TYPE", 12,
                                                                            00015200
           * FAS*, 14, * CBSERVATIONS, FROM*, 14, * TC*, 14, *, IN THE DOUD15300
                                                                            00015400
     /ATA ARRAYS )
                                                                            700015500
                                                     ZIXA-X
                                                                Y-AXIS
                                           TIME
 8C70 FCRMAT (1X, /, 1X, *
                             1
                                 MEIGHT*, /, (1X, 14, F16.6, 2X, 3F10.6, C0015600
               CONE ANGLE
     1-DXII
                                                                             00015700
           F14.4, F12.411
                                                    X-AXIS-1 Y-AXIS-1 Z-A00015800
                                           TIME
                             I
 BCBO FCRMAT (1X, /,1X, *
               X-AXIS-2 Y-AXIS-2 Z-AXIS-2 UHED ANGLE WEIGHT [1X, 14, FIE.E, 2X, 3FIC.6, 2X, 3F10.6, F14.4, F12.4)]
                                                DHED ANGLE WEIGHT , U0015900
     /x!S→1
                                                                            00016000
 8100 FURMAT (1X, //, 1X, "SIMULTANEOUS ATTITUDE EQUATIONS COEFFICIENTS 00016100
                                                                             00016200
          , /, 2X1
     1
                                                                             00016300
 8120 FCRMAT (1X, 1GE13.6)
 8200 +CRMAT (1X, //, 1X, 'ITERATION', 13, ' - ATTITUDE AND BIAS STATE: 00016400
           . //. 1x, CLC ALPHA(DEG) CHANGE(DEG) NEW ALPHA(DEGOO016500 DED DELTA(DEG) CHANGE(DEG) NEW DELTA(DEG)*) 00016600
 8220 FCRNAT (1X, 3F17.F, 4X, 3F17.8)
8230 FCRNAT (1X, /, 1X, *CLASS 1 (CCNE ANGLE) BIAS STATE: 1, 1X,
                                                                             00016700
                                                                             00861000
     / TYPE CLU BIASIDEG) CHANGE(DEG) NEW BIASIDEG)*)
                                                                             00016900
  8240 FORMAT (1X, /. 1X, *CLASS 2 (CHEC ANGLE) BEAS STATE: *. /. 1X+
                                                                             00017000
          *TYPE OLD BLASIDEG) CHANGE(DEG) NEW BLASIDEG)*)
                                                                             00017100
                                                                             00017200
  8245 FCRMAT (1X, 14, F16.6, F14.6, F16.6)
  8246 FCRMAT(1X,/, * ***** RESIDUAL EDITITING IS USED. ISMULT =*,15,/)
  8247 FORMAT( THE AVERAGE RHC VALUE FOR CLASS 1, TYPE 1, 13,
      / 1 EATA IS', F1C.4)
  8248 FCRMATI THE AVERAGE RHC VALUE FOR CLASS 2. TYPE .13.
     / ' [ATA [5",F10.4)
  8249 FORMAT(1X./, * THE AVERAGE RHC VALUE FOR ALL TYPES IS*.F10.4./)
  8250 FCRMAT(1x,/,1x, CCVARIANCE-CGRRELATION MATRIX ',/,1x,
                                                                             00017400
           10x, 13(1X, 2A4))
                                                                             00017500
  9260 FCRMAT (1X, 2A4, 2X, 13E9.2)
  8270 FCRMAT (1X, /, 18X, *CLASS 1 (CCAE ANGLE) ERROR STATISTICS: 1.
                                                                             00017600
            /. 1X+ * TYPE MEAN RESIDUAL(DEG) STANDARD DEVIATION(DEGOOD17700
                                                                             00017800
                TOTAL WEIGHT!)
      11
  8280 FORMAT (1x, /, 18x, *CLASS 2 (CHED ANGLE) ERROR STATISTICS:*,
                                                                             00017900
                                                    STANDARD DEVIATION (DEGCOOLBOOD
                             MEAN RESIDUALIDES)
            /, 1x, ' TYPE
                                                                             00018100
                 TOTAL WEIGHT*)
      11
  8290 FCRMAT (1X, 15, 4X, F13.4, 5X, 4X, F18.4, 5X, 8X, F12.4)
8295 FCRMAT (1X, TOTAL', 4X, F13.4, 5X, 4X, F18.4, 5X, 8X, F12.4)
                                                                             00018200
                                                                             00018300
                                                                             00018400
  8298 FCRMAT (1X. /, 1X. COMBINED TOTAL:
                                              MEAN RESIDUAL(DEG) = ",
                                                                             00018500
                       STANEARD DEVIATION(DEG) = 1, F9.41
      / F9.4. *
  8300 FERMAT (1X, /, 1X, ***** GCCNES CONVERGED!)
                                                                             00018600
  8320 FCRMAI (1x, /, 1x, ****** GCCNES PERFCRMED MAXIMUM NUMBER UF ITERA00018700
                                                                             00018800
      /TIONS WITHOUT CONVERGING!)
                                                                             00018900
  8340 FCRMAT (1X, 13C(*-*))
  8594 FCRMAT (1X. /. 1X. ***** ERKCR TYPE*, 13. * DETECTED, GCONES TERMCOO19000
                                                                             00019100
      /INATEC+1
                                                                             C0019200
       END
```

COFSUM

```
.00019400
C.
                                                                         .00019500
         THIS IS A SPECIAL SUPRCUTINE CALLED BY GCONES TO COMPUTE THE
С.
         CONTRIBUTION TO THE COEFFICIENTS OF THE SIMULTANEOUS EQUATIONS, CO019600
C .
         LINVERSE COVARIANCE MATRIX) FOR EACH TYPE OF DATA, ONE TYPE
                                                                         00019700
C.
         AT A TIME. THE COONES PREAMBLE AND COMMENTED LISTING PROVIDES. CO019800
€. .
                                                                          .00019900
         A CESCRIPTION OF ALL ARGUMENTS PASSED TO THIS SUBROUTINE.
                                                                          -00020000
                                                                         ..00020100
0.0
                                                                           00020200
      SUBREUTINE COFSUM (TIME, AXIS, ANG, WOHT, NUMB, ITYPE, NDIM, ALPR;00020300
                         CELR, BIAS, IBIAS, NCCF, TZERC, IWRT, IOUT,
                                                                           00020400
                        CCEF, CRHOSC, RHEST, AVGRHO, RHO)
                                                                           00020600
C
                                                                           00020700
                                                                           00020800
      DIMENSION TIME(500), AXIS(NDIM,500), ANG(500), WGHT(500),
                ALPRIA), CELRIA)
                                                                           00020900
     DIMENSION CEEF(13,13), ERHOSC(13), RHOST(3), DERIV(8)
                                                                           00021000
     · DIMENSION: REC(500)
      CATA RICC, TFLAC, XEIAS/57.29578,9999999..99999999./
                                                                           00021200
C ***** INITIALIZATION
                                                                           00021300
      IFRST = 1
      N2 = NCCF + NCCF
                                                                           00021400
                                                                           00021500
 ***** WRITE CUTPUT HEADER IR SPECIFIED
      IF(1WRT.GE.12) WRITE (ICUT.8CCG) ITYPE .
                                                                           00021600
                                                                           00021700
      CONTINUE
                                                                           00021800
                                                                           00021900
 ***** BECIN SUMMATION LEGE
                                                                           00022000
      BC 1000 I = 1,NUME
                                                                           00022100
                                                                           00022150
      REC(I)=C.C
C **** IF TIME IS FLAGGED IGNORE THIS EBSERVATION
                                                                           00022200
      IF(TIME(I).EC.TFLAG) GO TO 1000
                                                                           00022300
C ***** IF ATTITUDE IS INERTIAL (NCCF=1) AND HAS BEEN COMPUTED ONCE
                                                                           00022400
C ***** (IFRST=2) SKIP ATTITUDE COMPUTATION FROM COEFFICIENTS
                                                                           00022500
      IF(ACCF.LE.1 .AND. IFRS1.EQ.2) GC TO 100
                                                                           00022600
      1FRSI = 2
                                                                           00022700
      AR = C.C
                                                                           00022800
      DR = C.C
                                                                           00022900
      TOIFF = TIME(I) - TZERO
                                                                           00023000
      DTIME = 1.0
                                                                           00023100
C ***** CEMPUTE ALPHA AND DELTA AT TIME(1) -
                                                                           00023200
      DC + 4C + J = I \cdot NCCF
                                                                           00023300
                                                                           00023400
      \Delta R = \Delta R + \Delta LPR\{J\}*CTIME
      DR = GR + DELR(J)*DTIME
                                                                           00023500
      DIIME = DTIME*TO(FF
                                                                           00023600
   40 CONTINUE
                                                                           00023700
      IF (ABS(AR).LT.10000.0 .AND. ABS(ER).LT.10000.0) GD TO 60
                                                                           00023800
      IF(INRT.GE.12) WRITE (ICUT,8120)
                                                                           00023900
      SC 10 1000
                                                                           00024000
   EO CONTINUE
                                                                           00024100
C **** SAVE SINES AND COSINES OF ALPHA AND DELTA AND CARTESIAN
                                                                           00024200
C 4**** CCCRUINATES OF UNIT SPIN AXIS VECTOR
                                                                           00024300
      LESA = COSTAR)
                                                                           00024400
      51MA = SIN(AR)
                                                                           00024500
      CCSC = CUS(CR)
                                                                           00024600
      SINC = SIN(CR)
                                                                           00024700
      UI ≃ CDSD*CDSA
                                                                           00024800
      U2 = CGSO*SINA
                                                                           00024900
     U3 = 51ND
                                                                           00025000
  ICC CENTIALE
                                                                           00025100
                                                                           00025200
  ***** COMPUTE ANGLE AND DERIVATIVES W.R.T. ALPHAO AND DELIAC AT THE
                                                                           00025300
  **** CLRRENT STATE
                                                                           00025400
```

```
00025500
                                                                            00025600
C **** CEMPUTE TRUE MEASURED ANGLE (WITHOUT BIAS)
                                                                            00025700
      GAMMA = ANG(I)
                                                                            00025800
      IF(PIAS.NE.XPIAS) GAMMA = GAMMA - BIAS
                                                                            00025900
      W = WGHT\{I\}
                                                                            00026000
      16(11YPF.EC.2) GC TC 12C
C **** CLASS 1 DATA - CONE ANGLE
      CESTRE = AXIS(1,1)*L1 + AXIS(2,1)*U2 + AXIS(3,1)*U3
                                                                            00026200
      IF(ABS(CCSTFE).GT.1.0) (BSTFE = SIGN(1.0.COSTHE)
                                                                            00026300
                                                                            00026400
      THERAD = ARCES(COSIFE)
                                                                            00026500
      SINTE = SIN(THERAU)
                                                                            00026600
      THETA = THERAS*RTCO
      REC(I)=SAMMA-IFSTA
                                                                            00026800
      IF(SINTHE.NE.C.C) GC TO 110
                                                                            00026900
C **** DERIVATIVES CAN'T BE COMPUTED, SKIP THIS POINT
                                                                            00027000
      IF(IMRT.GE.12) WRITE (ICUT,8140)
                                                                            00027100
      GC TC 1000
                                                                            00027200
  110 CENTINUE
C **** CCYPUTE DERIVATIVES OF THETA W.R.T. ALPHAO AND DELTAG
                                                                            00027300
      DERVA = (\Delta XIS(1,I)*U2 - \Delta XIS(2,I)*U1)/SINTHE
                                                                            00027400
      DERVE=(SIND*(AXIS(1,1)*COSA+AXIS(2,1)*SINA)-AXIS(3,1)*CCSO)/SINTHEOOC27500
                                                                            00027600
      GC TC 140
                                                                            00027700
C **** CLASS 2 DATA - DIFERPAL ANGLE
                                                                            00027800
  120 CONTINUE
      E1 = \Delta X IS(2,1) * \Delta X IS(6,1) - \Delta X IS(3,1) * \Delta X IS(5,1)
E2 = \Delta X IS(3,1) * \Delta X IS(4,1) - \Delta X IS(1,1) * \Delta X IS(6,1)
                                                                            00027900
                                                                            00028000
      E3 = AXIS(1,I)*AXIS(5,I) - AXIS(2,I)*AXIS(4,I)
                                                                            00028100
      F = AXIS(1,1)*AXIS(4,1) + AXIS(2,1)*AXIS(5,1) +AXIS(3,1)*AXIS(6,1)C00282C0
       SV = L1*AXIS(1,1) + U2*AXIS(2,1) + U3*AXIS(3,1)
                                                                            CC028300
       SW = U1*AXIS(4*1) + U2*AXIS(5*I) + U3*AXIS(6*I)
                                                                            00028400
                                                                             00028500
       XNUM = L1#E1 + L2#E2 + L3#E3
                                                                            00028600
       XCEN = F - SV#Sh
       Q1 = XDEN \neq E1 + XNUM \neq (SV \neq AXIS(4,1) + SW \neq AXIS(1,1))
                                                                            00028700
                                                                             00028800
      Q2 = XDEN#E2 + XNEM#(SV#AXIS(S+I) + SW#AXIS(2+I))
                                                                             00028900
       C3 = XDEN*E3 + XNUM*(SV*AXIS(6,1) + SW*AX1S(3,1))
      IF(1hRT.GE.14) hRITE (1EUT. 8080) El, EZ, E3, F, SV, SW, XNUM, XDEN,
                                                                             00029000
                                                                             00029100
            01,62,63
      IF(XMLM.NE.O.C .CR. XCEN.NE.C.O) GO TO 130
                                                                             00029200
C ***** THETA IS ENDEFINED AND THE DERIVATIVES CAN'T BE COMPUTED
                                                                             00029300
                                                                             00029400
       IF(INRT.GE.12) WRITE (ICUT, 8160)
                                                                             00029500
       GE TE 1000
                                                                             00029600
   130 CCVLIVOE
                                                                             00029700
       THETA = ATAN2(XNUM, XUEN) #RTCD
                                                                             00029800
       TRETHETA.LT.C.C) THETA = THETA + 360.C
C ***** CCMPUTE RESIDUAL AND CHECK FOR NUMERICAL DISCONTINUITY AT 0-360 C0029900
                                                                             00030000
       REG(I)=GAMMA- THETA
       IF(ABS(RHO(1)).GT.270.0)R+O(1)=R+C(1)-SIGN(360.0.R+C(1))
                                                                             00030100
 C ***** IF REC IS STILL TCC LARGE ELIMINATE BY SETTING WEIGHT TO 0.0
                                                                             00030200
                                                                             00030300
      IF(ABS(RED(T)).GE.9C.C) h=0.0
                                                                             00030400
 C **** CCMPUTE BERIVATIVES OF THETA W.R.T. ALPHAD AND BELTAD
      .DERVA = (-G1*U2 + Q2*L1)/[XNUM#XNUM+XDEN*XDEN]
                                                                             00030500
       DERVC=(-SIND+(C1+CC5A+G2+SINA)+C3+CO5D)/(XNUM+XNUM+XDEN+XDEN)
                                                                             00030600
                                                                             00030700
   140 CENTINUE
 C ***** CCMPUTE VECTOR OF DERIVATIVES: AO, DO, A1, D1, ...
                                                                             00030705
                                                                             00030710
       CTIME = 1.0
                                                                             00030715
       DC 16C J = 2.N2.2
                                                                             00030720
       DERIV(J-1) = DERVA*ETIME
                                                                             00030725
       CERIV(J) = CERVC*CTIME
                                                                             00030730
       CTIME = CTIME*TCIFF
                                                                             00030735
   160 CENTINUE
                                                                             00806000
201721TAT2 MJ2 **** D.
                                                                             00030900
       RHCST(1) = RHCST(1) + RHC(1)*h
       RECST(2) = RECST(2) + RED(I)*REC(I)*W
                                                                             00031000
                                                                             00031100
       RPEST(3) = RPEST(3) + W
                                                                             00031200
       IF (INRT.LT.12) GC TC 150
 C ***** CLIPUI INTERMEDIATE QUANTITIES IN SUMMATION PROCESS
                                                                             00031300
```

```
AT = AR*RICE
                                                                         00031400
     CC = CR∜RICE
                                                                         00031500
      WRITE (IGUT-81CC) I. TIME(I). TRIFF, W. AD. OD. DERVA. CERVO.
                                                                         00031-600
                                                                         00031700
           THETA, GAMMA, REC(I)
                                                                         00031800
  150 CENTINUE
C ***** SUM MEIGHTED ALPHA AND DELTA COEFFICIENT DERIVATIVES CROSS
                                                                         00032600
C ***** PROCHETS INTO COFFFICIENT MATRIX (LOWER, LEFT, OFF-CIAGGNAL
                                                                         00032700
C ##### IS ACT SUMMED BECAUSE OF SYMMETRY)
                                                                         00032800
     DC = 2C_1C + 1 \cdot N2
                                                                         00032900
      DE 180 K = J.N2
                                                                         00033000
     CEEF(J.K) = CCEF(J.K) + DERIV(K)*DERIV(J)*W
                                                                         00033100
                                                                         00033200
  180 CENTINUE
C. ***** SLM CCEFFICIENTS IN VECTOR CONTAINING RIGHT SIDE OF SIMULTANEOUSGOO33300
C **** ECLATIONS
     ERHCSG(J) = ERHCSG(J) + RHC(I) * CERIV(J) * W
                                                                         00033500
  200 CENTINUE
                                                                         00033600
      IF(PIAS.EQ.XPIAS) GC TO 1000
                                                                         00033700
                                                                         00033800
     CENTIMIE
C **** COMPUTE ALL MATRIX ELEMENTS DEPENDENT ON BIAS
                                                                         00033900
                                                                         00034000
     DC 3CC J = 1.N2
      CCEF(J.IBIAS) = CCEF(J.IBIAS) + CERIV(J) *W
                                                                         00034100
  300 CENTINUE
                                                                         00034200
      CCEF(IBIAS, IBIAS) = CCEF(IBIAS, IBIAS) + W
                                                                         00034300
      CRHCSC(IBIAS) = LRHCSC(IBIAS) + RHC(I)*W
                                                                         00034400
 TOOM FOR TIMES
                                                                         00034500
C **** CCMPUTE AVERAGE REG. VALUE
      AVGREC=999.
      RHCSUM=C.O
                                                                         00034800
      NLM=C
     DC 1500 I=1.AUMB
                                                                         00034900
      [F([]NE([]].E(.TFLAG) GC TO ISCO
                                                                         00035000
      IF(WGFT(1).EC.C.O) GC TO 150C
                                                                         00035100
      REGSUM=RHOSUM+ABS(REG(I))
                                                                         00035400
     NUM=NUM+1
 1500 CENTINUE
                                                                         00035500
      IF (NUM. EQ. 0) GC. TO 2000
      AVGREC = REGSEM/NUM
 2000 RETURN
8000 FERMAT (1x, 7, 1x, *SUBROUTINE CLESUM - ATTITUDE EQUATIONS COEFFIC
     /IENIS COMPUTATIONS FOR CLASS!, 12, * DATA: *,
          77. 1X. 1
                         1
                                  TIME
                                             IDIEE
                                                         WEIGHT
                                        CERVE
                                                    THETA
     7Ea
              DELTA
                                                              CAMMA
           RHC1, /, 2X)
 8080 FORMAT (1X, "61,2,3=", 3F8.4, " F,SV,SW=", 3F8.4, "
                                                             XNUM, XDEN=*,
           258.4, * $1.2.3=*, 358.4)
 BICC FCRMAT (IX, I6. 5F12.4, 5F12.6)
B12C FCRMAT (IX, ****** THE ARSCLUTE VALUE OF ALPHA AND/OR CELTA IS TO
     ./C LARGE (>=1CCCCCO.O RADIANS) ()
 8140 FORMAT [1X, ****** SIN(THETA)=0.0, DERIVATIVES OF THETA W.R.T. AL
     '/PHA AND DELTA ARE UNDEFINED!)
 8160 FORMAT (LX, ****** PSI IS,UNCEFINED, DERIVATIVES OF PSI W.R.T. AL
     /PHA AND DELTA ARE ALSE ENCEFINED!)
     END
```

APPENDIX B

This appendix describes a computer program written to enable a user to employ SUBROUTINE GCONES with relatively small groups of data. The program is designed to make use of an IBM 2260 display unit for interactive input entry and output viewing. Examples of input and output follow, with a definition of the parameters and data which are displayed. In addition, a short guide for operation of the program is included at the end.

| Parameter | Format | Range of Values | Function or Definition |
|-----------|--------|-----------------|---|
| NCOF | (I1) | . 1 | Number of coefficients to be used in attitude model |
| MAXIT | (12) | 1 to 99 | Maximum number of iterations to be performed |
| NCLAS1 | (I1) | 1 to 5 | Number of types of class 1 (cone angle) data |
| NCLAS2 | (II) | 1 to 5 | Number of types of class 2 (dihedral angle) data |
| ISMULT | (II) | 0 | Do not use the residual edit data rejection process |
| · | . • | 1 to 9 | Weight to 0.0 all angles whose residuals are greater than ISMULT times the average residual |
| IRADEC | (I1) | 0 | Reference vectors are input in X, Y, Z coordinates |
| | | 1 | Reference vectors are input in α , δ coordinates |
| ALP(1) | (F5.1) | 0. to 360. | Initial estimate for spin axis right ascension |

| Parameter | Format | Range of Values | Function or Definition |
|------------|----------|-----------------|---|
| DEL(1) | (F5.1) | -90. to 90. | Initial estimate for spin axis declination |
| ALPBND(1) | (F3.2) | >0. | Bound for convergence of right ascension |
| DELBND(1) | (F3.2) | >0. | Bound for convergence of declination |
| NTYPE1 | (512) | 0 to 50 | Number of angles of each type of class 1 data |
| NUM1 | (I2) | 0 to 50* | Total number of angles of class 1 data |
| NTYPE2 | (512) | 0 to 50 | Number of angles of each type of class 2 data |
| NUM2 | (I2) | 0 to 50* | Total number of angles of class 2 data |
| BIAS1 | (5F5, 2) | 0.0 | Do not compute bias for this type of class 1 data |
| , | | Other | Initial estimate of bias for this type of class 1 data |
| BBND1 | (5F5.2) | ≥0, | Bound for convergence on bias for each type of class 1 data |
| BIAS2 | (5F5.2) | 0.0 | Do not compute bias for this type of class 2 data |
| | | Other | Initial estimate of bias for this type of class 2 data |
| BBND2 | (5F5, 2) | ≥0. | Bound for convergence on bias for each type of class 2 data |
| ANGLE | (F6, 2) | 0. to 360. | Cone angles and/or dihedral angles (cone angles must be first) |
| X1,Y1,Z1 | (3F11.7) | -1. to 1. | X, Y, Z coordinates of first reference vector |
| X2, Y2, Z2 | (3F11.7) | -1. to 1. | X, Y, Z coordinates of second reference vector (for dihedral angles only) |

^{*}At present the program is limited to processing only 50 angles or less. (NUM1 + NUM2 ≤ 50)

| Parameter | Format | Range of Values | Function or Definition |
|--|--|--|---|
| A1 | (F11.7) | 0. to 360. | Right Ascension of first reference vector |
| D 1 | (F11.7) | -90. to 90. | Declination of first reference vector |
| A2 | (F11.7) | 0 to 360. | Right ascension of second reference vector (for dihedral angles only) |
| D2 | (F11.7) | -90. to 90. | Declination of second reference vector (for dihedral angles only) |
| WGHT | (F5.2) | ≥0.0 | Weights assigned to each input angle |
| RESID1 = 0.0 STDV1 = 0.0 RESID2 = -0.00 | * 0.0 * 0.0 | * 0.0 * 0.0 * 0.0 * 0.0 009* 0.0 * 0.0 | TRESID= 0.25098 *** TSTOV= `0.25000 * 0.0 |
| 3* 57.89* | 0.2049* 1.0 0.0949* 1.0 | 00* * a | I*ANGLE *RESIDUAL*WEIGHT* 2* 85.23* -0.2051* 1.00* 4* 57.70* -0.0951* 1.00* |
| *A_P(1) = 45.4 *NTYPF1 = 0 * 0 *BIAS! = 0.00 *BIAS2 = 0.00 ANGLE XI OF 95.64 * -0.9 35.23 * -0.9 | 4*DEL(1)= -: 0* 0* 0* 0* 0* 0* 0* 0* 0* 0* 0* 0* 0* 0* 0* 0* 0* A1 | * 0.0 * C.0 ***** 6 * C.0 * C.0 ***** 6 R D1 | |

Output Description

***** message — error message from SUBROUTINE GCONES. If no error occurs, message is "GCONES CONVERGED"

ALPHA — computed spin axis right ascension

DELTA — computed spin axis declination

TRESID — computed mean residual based on all data

TSTDV — computed standard deviation based on all data

RESID1 — mean residuals computed for each type of class 1 data

STDV1 — standard deviations computed for each type of class 1 data

RESID2 — mean residuals computed for each type of class 2 data

STDV2 - standard deviations computed for each type of class 2 data

BIAS1 — bias computed for each type of class 1 data

BIAS2 — bias computed for each type of class 2 data

I — number of the angle within the input angle arrays

RESIDUAL - residual computed for this individual angle

WEIGHT — weight attached to this angle (if residual edit was used and the

residual was large enough this weight will be 0.0).

Operating Guide

The normal procedure for operation is to: 1. enter all input parameter values and data on the input displays, 2. process the data using Subroutine GCONES, 3. review the output on the output displays, 4. proceed to the input display where more data can be entered or the same data can be reprocessed, 5. repeat previous procedure any number of times.

To facilitate these operations, several features have been incorporated into the program for input as well as for output.

Input Features

Shift/Enter — by depressing these keys the next page of input will be displayed.

There are five pages of input. If shift/enter is depressed when page 5 is on the display, GCONES processing is initiated and the

output display will appear.

BACK — by typing "BACK" in the first four spaces on the first line of any

page and then depressing shift/enter the previous page of input

will be displayed.

SKIPn - by typing "SKIP" in the first four spaces on the first line of any

page and typing a "1", "2", or "3" in the fifth space, n pages of input can be skipped. Shift/enter must be depressed after typing

SKIPn.

LOAD — by typing "LOAD" in the first four spaces on the first line of any page and then depressing shift/enter page 1 of the input will be

page and then depressing shift/enter page 1 of the input will be displayed.

CONT

- by typing "CONT" in the first four spaces on the first line of any page and then depressing shift/enter the GCONES processing will be initiated without further modification to the input data.

STOP

- by typing "STOP" in the first four spaces on the first line of any page and then depressing shift/enter the program will be terminated.

Output Features

Shift/enter - same as with input

BACK - same as with input

LOAD — same as with input

STOP - same as with input

REDO — by typing "REDO" in the first four spaces on the first line of any page and then depressing shift/enter the first page of output will

be displayed. There can be up to four pages of output.

Operating Notes

When the initial input has been processed, the output reviewed, and "LOAD" is used to reprocess several things should be noticed. First, the input attitude and bias estimates will be those computed by GCONES from the previous processing and may require modification. Second, the weights will be 0.0 if any of the angles were rejected by the residual edit process. Third, the line immediately following the last line of data from the previous processing will be blank. Data should be entered on this line if more angles are added (asterisks need not be typed).

```
//GHARGCO$ JOB (GH5001857A, T, G00402, 005005), GHO, MSGLEVEL=1
// EXEC PGM=IEHPROGM
//SYSPRINT DD SYSOUT=A
//ATT DD UNIT=DISK, VOL=SER=ATTDET, DISP=SHR
//SYSIN DC *
SCRATCH DSNAME=IMP.LAUNCH.GDR.VOL=2314=ATTDET.MEMBER=GCONESDR
// EXEC PGM=IEBCOPY, REGION=20CK
//SYSPRINT DD SYSOUT=A
//IN OD DSN=IMP.LAUNCH.GDR,UNIT=DISK+VOL=SER=ATTDET.DISP=SHR
//SYSIN DD *
 COPY INDD=IN.OUTDD=IN.
// EXEC FORTRANH
//SOURCE.SYSIN DD *
                                                                            00000100
      THIS IS A GENERAL DRIVER FOR SUBROUTINE GCONES
                                                                            00000200
¢
                                                                            00000300
C
      WRITTEN 7/20/72 BY AL GEELHAAR -- CODE 542
      REVISED 10/27/72 TO INCLUDE CALL TO LATEST VERSION OF GCONES
C
                                                                            00000400
      DIMENSION ALP(4), DEL(4), ALPBND(4), DELBND(4), COEF(13,13),
     / TIME1(50), AXIS1(3,50), ANG1(50), IFRST1(5), NTYPE1(5),
     / BIASI(5), BBND1(5), RHOSTI(3,5), TIME2(50), AXIS2(6,50),
     / ANG2(50), WGHT2(50), IFRST2(5), NTYPE2(5), BIAS2(5),
     / BBND2(5),RHOST2(3,5),WGHT1(50),STDV1(5),RESID1(5),RHO1(50),
     / STDV2(5), RESID2(5), RHO2(50), ICOM(7), B1(5), B2(5)
      COMMEN/GRAPH/ ICOM
      ISMULT=0
      IRADEC=0
                                                                            00001300
      NCOF=1
                                                                            00001400
      TZERC=O.
      MAXIT=5
                                                                            00001600
      IWRT=14
      IOUT≃6
                                                                            00001700
                                                                            00001800
      NCLAS1=0
                                                                            00001900
      NCLAS2=0
      DUM1=0.0
      DUM2=0.0
      DUM3=0.0
      NUM1=50
      NUM2=0
      ALP(1)=0.0
      DEL(1)=0.0
      IFT=10
      IUNIT=9
      I DUM=0
      00 1 I=1,4
ALPBNO(1)=.1
                                                                             00002000
                                                                             00002100
                                                                             00002200
      DELBND(1)=.1
                                                                             00002300
    1 CONTINUE
      DO 2 I=1,5
      RESIDI(I)=0.0
      STDV1(I)=0.0
      RESID2(1)=0.0
      STDV2(I)=0.0
       [FRST]([]=0
      IFRST2(I)=0
      NTYPEL(I)=0
      NTYPE2(I)=0
                                                                             00002500
      BIAS1(1)=9999999.
      BIAS2[1]=99999999.
      81(1)=0.0
      B2(1)=0.0
      BBNC1(1)=0.0
      BBND2([]=0.0
                                                                             00002700
    2 CONTINUE
      DO 3 I=1.50
       ANG1(1)=0.0
```

```
ANG211) =0.0
                                                                         00002900
   WGHT1(1)=1.
   WGHT2(I)=1.
                                                                         00003000
                                                                         00003100
   I = (I)IBMIT
                                                                         00003200
   TIME2(1)=1
   CO 21 J=1.3
21 AXISI(J.I)=0.0
   00.3 J=1.6
   AXIS2(J.I)=0.0
                                                                         00003300
 3 CONTINUE
   CALL GOPEN(IFT. [COM(1)]
   CALL GSPAR(ICUM(1))
 4 REWING 9
   WRITE(9,9000)NCOF, MAXIT, NCLAS1, NCLAS2, ISMULT, IRADEC, ALP41), DEL(1).
  /ALPBND(1), DELBND(1), (NTYPE1(1), I=1,5), NUM1, (NTYPE2(1), I=1,5),
  /NUM2, (B1(I), I=1,5), (BBNC1(I), I=1,5), (B2(I), I=1,5), (BBND2(I), I=1,5)
   TE(NUML_NE_O) GO TC 22
   WRITE(9.9020) (ANG2(I).(AXIS2(J.I).J=1.6),WGHT2(I).I=1.NUM2)
   GO TO 25
22 [F(NUM2.NE.O) GO TC 23
   WRITE(9,9020)(ANG1(1),(AXIS1(J,I),J=1.3),DUM1,DUM2,DUM3.
  / WGHT1(1), I=1, NUM1)
   GO TO 25
23 WRITE(9,9020)(ANG1(I),(AXIS1(J,I),J=1,3),DUM1,DUM2,DUM3,
  / WGHT1(I), (=1, NUM1), (ANG2(I), (AXIS2(J, I), J=1,6), WGHT2(I), I=1, NUM2)
25 CONTINUE
   IGD = 1
   CALL DUMMY(IGO.IUNIT.IDLM)
   READ(9,9000) NCOF, MAXIT, NCLAS1, NCLAS2, ISMULT, IRADEC, ALP(1), DEL(1),
  /ALPBND(1),DELBND(1),(NTYPE1(1),I=1,5),NUM1,(NTYPE2(1),I=1,5),
  /NUM2, (B1(1), I=1,5), (BBND1(1), I=1,5), (B2(1), I=1,5), (BBND2(1), I=1,5)
   IF(NUM1.NE.O)
                  GO TO 32
   READ (9,9020) (ANG2(I), (AXIS2(J, I), J=1,6), WGHT2(I), I=1, NUM2)
   GO TO 35
32 IF(NUM2.NE.O) GO TO 33
   READ (9,9020)(ANG1(1),(AXIS1(J,1),J=1,3),DUM1,DUM2,DUM3,
  / WGHT1(I).I=1.NUM1)
   GO TO 35
33 REAC (9,9020)(ANG1(I),(AXIS1(J,I),J=1,3),DUM1,DUM2,DUM3,
  / WGHT1(I), I=1, NUM1), (ANG2(I), (AXIS2(J,I), J=1,6), WGHT2(I), I=1, NUM2)
35 CONTINUE
   REWIND 9
   N=NUM1+NUM2
   NLINES=N/2+N/22+13
   NLINES=NLINES+MOD(N,2)
   IF(MOD(N.22).EQ.O) NLINES=NLINES-1
                    GO TO 9
   IF(IRADEC: LE.O)
   IF(NCLAS1.LE.O)
                     GO TO 6
   DO 5 I=1, NUM1
   R=AXISI(1,1)/57.29578
   D=AXIS1(2,1)/57.29578
   AXIS1(1,1)=COS(R)*COS(D)
   AXISI(2,I)=SIN(R)*CCS(D)
 5 AXISI(3,1)=SIN(D)
 6 IF(NCLAS2.LE.O) GO TO 9
   DO 8 I=1,NUM2
   RF=AXIS2(1.1)/57.29578
   DF=AXIS2(2,1)/57.29578
   RS=AXIS2(3,1)/57.29578
   DS=AXIS2(4+1)/57+29578
   AXIS2(1+I)=COS(RF)*COS(DF)
   AXIS2(2,I)=SIN(RF)*COS(CF)
   AXIS2(3,1)=SIN(DF)
   AXI52(4+I)=COS(RS)*COS(CS)
   AXIS2(5,1)=SIN(RS)*COS(CS)
```

8 AXIS2(6,1)=SIN(DS)

```
9 CONTINUE
     DO 37 I=1,5
     BIAS1(I)=9999999.
     BIAS2(1)=99999999.
     IF(81(1).EQ.0.0) GC TO 36
     BIASI([]=B1([)
  36 IF(B2(I).EQ.O.O) GC TO 37
     BIA52(I)=B2(I)
  37 CONTINUE
     IFRST1(1)=1
     IFRST2(1)=1
     DO 38 I=2,5
     IFRST1(I) = IFRST1(I+1) + NIYPE1(I+1)
     IFRST2(I)=[FRST2(I-1)+NTYPE2(I-1)
  38 CONTINUE
     CALL GCONESITZERO, ALP, DEL, ALPBND, DELBND, NCOF, MAXIT, CDEF.
    / IWRT, I DUT, IRET, I SMULT, TI ME1, AX IS1, ANG1, WGHT1, IFRST1, NT YPE1,
    / BIASI,BBND1,RHOST1,NCLAS1,RHO1,RESID1,STDV1,FIME2,AX1S2,ANG2,
    / WGHT2, IFRST2, NTYPE2, BIAS2, BBND2, RHOST2, NC LAS2, RHO2, RESID2,
    / STDV2, TRESID, TSTDV)
     00 40 I=1,5
     B1(1)=B1A51(1)
     82(I)=8IAS2(I)
     IF(BIAS1(I).GE.99999.) B1(I)=0.0
     IF(BIAS2(1).GE.99999.) B2(1)=0.0
  40 CONTINUE
     I=IRET+1
     GO TO (11,12,13,14,15,16),I
  11 WRITE(9,9001)
     GO TO 20
  12 WRITE(9,9002)
     GG TO 2.0
  13 WRITE(9,9003)
     GO TO 20
  14 WRITE(9,9004)
     GO TO 20
  15 WRITE(9,9005)
     GO TO 20
  16 WRITE(9.9006)
 20 WRITE(9;9010) ALP(1), DEL(1), TRESID. TSTDV. (RESIDI(1). (=1.5).
   / (STDV1(I), I=1,5),
    /(RESID2(I), I=1,5), (STDV2(I), I=1,5), (B1(I), I=1,5), (B2(I), I=1,5)
     IF(NUM1.NE.O) GD TC 42
     WRITE(9,9030)
                       (I.ANG2(I).RHD2(I).WGHT2(I).I=1.NUM2)
     GO TO 45
  42 IF(NUM2.NE.O)
                     GD TO 43
     WRITE(9,9030)
                        (I, ANG | (I), RHO| (I), WGHT| (I), I=1, NUM1)
     GO TO 45
  43 WRITE(9,9030) (I,ANG1(1),RHO1(I),WGHT1(I),I=1,NUM1),(I,ANG2(I),
    / RHC2(1), WGHT2(1), I=1, NUM2)
  45 CONTINUE
     IOUM=NLINES
     IG0=2
     CALL DUMMY(IGO, IUNIT, IDUM)
     IF(IDUM.EQ.-555) GC TO 4
     CALL GDAR(ICOM(1))
     CALL GCLOS(IFT.ICOM(1))
9C00 FORMAT( * *NCOF= *, 11, **MAXIT= *, 12, **NCLAS1= *, 11, **NCLAS2 = *, 11,
    / **ISMULT=", I1, **IRADEC=*, I1, ***/* *ALP(1)=*, F5.1, **DEL(1)=*, F5.1,
    / "*ALPBND(1)=",F3.2,"*DELBND(1)=",F3.2,"*"/" *NTYPE1=",5([2,"*"),
     ***NUM1=*,12,***** NTYPE2=*,5(12,***),***NUM2=*,12,***/
    /* *BIAS1=",5(F5.2,***), ***** BBND1=*,5(F5.2,***)/* *BIAS2=*,
/ 5(F5.2, **1), **** BBND 2= *, 5(F5.2, **1))
9020 FORMAT( * ANGLE X1 OR A1 Y1 OR D1 Z1 OR A2 X2 UR D2 *, 6X,
    / "Y2",9X,"Z2",6X,"WGHT",6(/F7.2,"*",6(F10.6,"*"),F5.2,"*"),
    / 41/ ANGLE X1 OR A1
                               Y1 OR D1 Z1 OR A2 X2 OR U2*,6X,*Y2*,
```

```
/ 9X,1221,6X,1#GHT1,
        / 11(/F7.2. ** ,F10.6,         / F10.6. *** . F5.2. *** )))
9CO1 FORMATI' ***** GCONES CONVERGED')
9CO2 FORMAT( * **** GCONES PERFORMED MAXIMUM NUMBER OF ITERATIONS .
        / * WITHOUT CONVERGING*)
9003 FORMATI * **** GCONES DIVERGED (CORRECTION ELEMENT GREATER THAN'.
        / 1 360.11
9004 FORMAT( * **** GCONES ENCOUNTERED A SINGULAR MATRIX!)
9CD5 FORMAT(* ***** GCONES - TOO MANY BIASES WERE SELECTED TO BE ..
        / 'DETERMINED')
9006 FORMAT(* ***** GCONES - NCOF IS OUTSIDE OF ALLOWABLE RANGE*)
9010 FORMAT(/ ALPHA= , F8.3, * *** DELTA= , F8.3, * **** TRESID= .
        / F9.5,' *** TSTDV=',F9.5,//' RESID1=',F9.5,
        / ***,F9.5, ***,F9.5, ***,F9.5, ***,F9.5, ***/* STDV1 =*,5(F9.5, ***)/
        / ! RESID2=1,5(F9.5,1*1)/! STDV2 =1,5(F9.5,1*1),
/ / BIAS1 = 1,5(F9.5,1*1),/ BIAS2 = 1,5(F9.5,1*1))
9030 FORMATH//3(' I*ANGLE *',
        / 'RESIDUAL*WEIGHT*',14X, ** I*ANGLE *RESIDUAL*WEIGHT*'/11(13, **',
        / F6.2, ***, F8.4, ***, F6.2, ***, 14X, ***, 12, ***, F6.2, ***, F8.4,
        / !*!,F6.2.!#!,/)))
          STOP
                                                                                                                                                        00003900
          END
                                                                                                                                                        00004000
          SUBROUTINE DUMMY(IGO, LUNIT, IDUM)
          IF (IGO .EQ. 1) CALL LOAD(IUNIT)
          IF (IGO .EQ. 2) CALL OUT60(IDUM, IUNIT) -
          IF (IGO .EQ. 3) CALL COPY(IDUM.IUNIT)
          RETURN
          ENĎ
          SUBROUTINE COPY(IRECN.IUNIT)
          DIMENSION ALZ401-ICCM(7)
          COMMON /GRAPH/ICOM
          DATA ASTOP/ISTOPI/
          DATA BLOAD/'LOAD'/
          DATA AUTO/'AUTO'/
          IFT=10
          REWIND JUNIT
          READ(IUNIT, 10, END=25)A
    10 FORMAT(2044)
    25 CALL GWBUF(ICOM(1), A(1), IFT)
          CALL GWAIT(ICDM(1))
          CALL GRBUF(ICOM(1).A(1).IFT)
          IF(A(1) .EQ. ASTOP) GO TO 30
          IF(A(1) .EQ. AUTO) IRECN=-444
IF(A(1) .EQ. BLOAD) IRECN=-555
          REWIND JUNIT
          WRITE(IUNIT, 10) A
          REWIND JUNIT
          RETURN
    30 CALL GDAR(ICOM(1))
          CALL GCLOS([FT, ICOM(1))
          STOP
          END
          SUBROUTINE LOAD(IUNIT)
          DIMENSION ICOM(7),A(1200)
          DATA SKIP/*SKIP*/,STOP/*STOP*/
          DATA CONT/'CONT'/, BACK/'BACK'/, BLOAD/'LOAD'/
                                                                                                                                                        00003322
          INTEGER L(5)/1,241,481,721,961/
          COMMON /GRAPH/ICOM
                                                                                                                                                        00003330
          ISKIP=0
          1FT=10
                                                                                                                                                        00003340
          REWIND JUNIT
          READ (IUNIT, 10, END=24) A
    10 FORMAT(20A4)
                                                                                                                                                        00003370
   24 I=0
                                                                                                                                                        00003371
   25 I=I+1
                                                                                                                                                        00003372
```

```
IF(1.GT.5) I=5
      IF ([.EQ.0] [=]
                                                                                00003374
      J=L(1)
      (L)A=A
      S=A(J+1)
                                                                                00003377
      CALL GWBUF (ICOM(1), A(J), IFT)
      ISKIP=ISKIP-I
     IF(ISKIP.GT.O) GO TC 25
                                                                                00003378
      CALL GWAIT (ICOM(1))
                                                                                00003400
      CALL GRBUF(ICOM(1), A(J), IFT)
                                                                                00003404
   20 D=A(J)
      Q=A(J+1)
      A(J)=R
      A(J+1)=S
      IF(D.EQ.SKIP) GO TO 92
                                                                                00003407
      IF (D.EC.BLGAD) GO TO 24
                                                                                00003408
      IF(D.EQ.BACK) I=I-2
                                                                                00003409
      IF(D.EQ. CONT) GO TC 26
      IFIC.EQ.STOP) GO TO 27
      IF(I.NE.5) GO TO 25
                                                                                00003411
   26 REWIND IUNIT
                                                                                00003420
      WRITE(IUNIT, 10)A
                                                                                00003430
      REWIND JUNIT
                                                                                 00003440
      RETURN
   27 CALL GDAR (ICOM(1))
CALL GCLUS(IFT, ICOM(1))
      CALL EXIT
   92 CALL INCORE(Q.15KIP.5,1,1,0,0)
      ISKIP=ISKIP+1
      GO TO 25
      END
      SUBROUTINE OUTGO (IRECN, IN)
      DIMENSION B(240), [COM(7)
      PROGRAM TO DISPLAY A DATA SET ON 2260
C
      INPUT UNIT
      DATA R.BLANK/ REDO ...
      DATA STOP/*STOP*/
      DATA BACK/ BACK 1/
      DATA BLOAD/'LOAD'/
      DATA AUTO/ AUTO!/
      COMMON /GRAPH/ICOM
      IFT=10
      REWIND IN
    5 LINEKT=0
    1 L=1
      K=20
      D0 2 I=1/12
       IF(LINEKT .EQ. IRECN) GC TO 90
       READ (IN, 100, END=90, ERR=90) (B(J), J=L,K)
       BSAVE=8(1)
      LINEKT=LINEKT+1
      L=20*1+1
       K=L+19
    2 CONTINUE
  100 FORMAT(20A4)
       WRITE 12 LINES ON 2260
       CALL GWBUF (ICOM(1), B(1), IFT)
       CALL GWAIT(ICOM(1))
       CALL GRBUF (ICOM(1), B(1), IFT)
       IF(8(1).EQ. STOP) GO TO 91
  IF (B(1) .EQ. BLOAD) GO TO 77
IF (B(1) .NE. BACK) GO TO 200
140 IF(LINEKT .LE. 12) GO TC 76
       KBACKS=24
       IF(MOD(LINEKT,12) .NE. C)KBACKS=MOD(LINEKT,12)+12
       DO 150 JJ=1,KBACKS
```

```
LINEKT=LINEKT-1
  150 BACKSPACE IN
  200 IF (B(1) .NE. R) GO TO 1
   76 REWIND IN
      GO TO 5
   90 IF(MOD(LINEKT, 12) .EQ. C) GO TO 11
      IS=(I-11*20+1
      DO 3 I=15,240
                                                                           00002420
    3 B(I)=BLANK
      GO TO 10
   11 B(1)=BSAVE
   10 CALL GWBUF(ICOM(1),B(1),IFT)
      BSAVE=8(1)
      CALL GWAIT([COM(1])
C.
      READ 12 LINES FROM 2260 + TEST FIRST CHARACTER
      CALL GRBUF(ICOM(1), B(1), IFT)
      IF(B(1) .EQ. BLOAD) GO TO 77
      IF(B(1) .EQ. AUTO) GO TC 75
      IF(B(I) .EQ. STOP) GO TC 91
      IF(8(1) .EQ. R) GO TO 76
      IF (8(1) .NE. BACK) GO TO 11
      GO TO 140
      75 IRECN=-444
         RETURN
      77 IRECN=-555
      91 CONTINUE
         RETURN
         END
   // EXEC LINK
   //SYSLIB DD DSN=OPRLIB, UNIT=DISK, VOL=SER=ATTDET, DISP=SHR
   //SYSLMOD DD DSN=IMP.LAUNCH.GCR(GCUNESDR),UNIT=DISK, VOL=SER=ATTDET,
   // DISP=SHR, SPACE=(TRK, (1,4,1), RLSE)
   // EXEC PGM=GCUNESDR, REGION=120K
   //STEPLIB DD DSN=IMP.LAUNCH.GCR.DISP=SHR.VOL=SER=ATTDET,UNIT=2314
   //FTO6FOO1 DD SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLK5IZE=7265)
   //FT09F001 DD DSN=&&ARGLIN, DISP=(NEW, DELETE), SPACE=(TRK, (3, 1)),
   // DCB=(DSORG=PS, RECFM=F, LRECL=80, BLKSIZE=80), VOL=SER=G1SCR6, UNIT=2314
   //FT10F001 DD UNIT=0A4
   /*
```

APPENDIX C

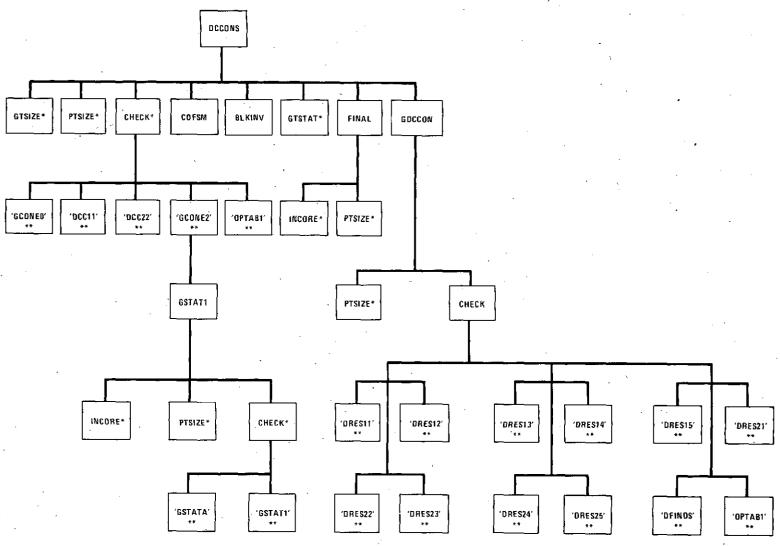
SECTION 1 INTRODUCTION

DCCONS is the inter-active graphics counterpart of the non-interactive program; GCONES (Ref. 1). GCONES is a differential correction routine that minimizes the weighted sum of residuals squared between measured and computed angles. The measured angles may be obtained directly from spacecraft sensor readings or computed from other spacecraft observations such as time pulses, spin rates, or components of a reference vector. The minimization is achieved by differentially correcting an a priori estimate of the attitude state variables.

SECTION 2 MODULE DESCRIPTION

Section 2 contains the module descriptions of all subroutines accessed by the DCCONS subsystem. The following conventions should be noted:

- The standard IBM System/360 FORTAN IV Library Subprograms are used for nominal arithmetic and trigonometric calculations.
- All calls to graphics displays are accomplished through the MSAD routine, CHECK (see Ref. 14).
- Each module description contains six main parts
 - a. CALLING SEQUENCE reflects the physical call to the subroutine;
 - b. DESCRIPTION presents a brief overview of the function of the module;
 - c. COMMON AREAS REFERENCED lists, in alphabetical order, the labeled common areas accessed by the module;
 - d. EXTERNAL REFERENCES lists, in alphabetical order, all external routines called by the module;
 - e. STORAGE REQUIREMENTS delineates the amount of physical core storage, in decimal bytes, required by the module;
 - f. VARIABLES defines the input parameters and output variables accessed by the module along with any labeled COMMON area variables utilized in the module.
- In addition to the six main parts, two parts are provided, where applicable
 - a. DATA TRANSMISSION lists the unit of transmission, the type of transmission and a description of the data being transmitted. Data transmitted through MSAD display devices is listed as Control Point name, the module which calls the display, and the display description.
 - b. RESTRICTIONS delineates the limitations imposed on the module.



LEGEND

* - MSAD SUBROUTINES

** - TABLE DISPLAY NAMES

SUBROUTINE DCCONS

CALLING SEQUENCE: CALL DCCONS (ALP, ALPBND, ALPCUM, DEL, DELBND, DELCUM, ARGCUM, TIME1, AXIS1, ANG1, WGHT1, IFRST1, NTYPE1, BIAS1, BBND1, RHOST1, RHO1, CALC1, SCOEF1, TIME2, AXIS2, ANG2, WGHT2, IFRST2, NTYPE2, BIAS2, BBND2, RHOST2, RHO2, CALC2, SCOEF2, AVGRHO, COEF, DRHOSQ, CHNG, STOR1, STOR2, ALPR, DELR, STYPE1, STYPE2, BTYPE, RL, WORK, GWORK0, GWORK4, GWORK5, B11CUM)

DESCRIPTION:

DCCONS is a version of GCONES designed to operate under the Multi-Satellite Attitude Determination (MSAD) executive system.

COMMON AREAS REFERENCED: DSCOPT, GCN1, MASCOM, STVEC

EXTERNAL REFERENCES:

ABS, AMAX1, BLKINV, CHECK, COFSM, FINAL2, GDCCON, GTSIZE, GTSTAT, MAX0, MESAGE, MIN0, PTSIZE, SQRT

STORAGE REQUIREMENTS: 16,222 bytes of core storage

VARIABLES:

| Variable <u>Name</u> | $\underline{	ext{Type}}$ | Origin | <u>I/O</u> | <u>Description</u> |
|-------------------------|--------------------------|--------|------------|--|
| ALP | R*4 | CS | I/O | On input a priori estimate of polynomial coefficients for right ascension, in degrees (i.e, R.A. = ALP(1) + ALP(2) * T + ALP(3) * T ² + ALP(4) * T ³ , where T = time of observation). On output, the final results. |
| ALPBND | R*4 | CS | Ι | Convergence bounds for ALP, in degrees. |
| ALPCUM | R*4 | CS | O | Cumulative results for ALP(1). (e.g., ALPCUM(5) contains the value of ALP(1) obtained for the fifth iteration). |

| Variable Name | Type | Origin | <u>I/O</u> | Description |
|------------------|------|--------|------------|---|
| DEL | R*4 | CS | I/O | On input a priori estimate of polynomial coefficients for declination, in degrees, (i.e., D = DEL(1) + DEL(2) * T + DEL(3) * T ² + DEL(4) * T ³ , where T = time of observation). On output, the final results. |
| DELBND | R*4 | , | r . | Convergence bounds for DEL, in degrees. |
| DELCUM | R*4 | CS | O . | Cumulative results for DEL(1). (e.g., DELCUM(4) contains the value of DEL(1) obtained for the fourth iteration). |
| ARGCUM | I*4 | CS | 0 | Iteration indicator for values in ALPCUM, and DELCUM |
| TIME1 | R*4 | CS | ı | Reference times for Class 1 (cone angle) data. |
| AXIS1 | R*4 | cs | I ; | Reference unit vectors for Class 1 data (dimensioned 3* number of Class 1 observations). |
| ANG1 | R*4 | CS | I | Class 1 (cone angle) observations in degrees, (acceptable range 0° - 180°). |
| WGHT1 | R*4 | CS | I/O | Class 1 weights. |
| IFRST1 | I*4 | CS | , I | Pointers indicating starting positions for each type of Class 1 data in the arrays: TIME1, AXIS1, ANG1, and WGHT1. |
| NTYPE1 | I*4 | CS | 1 | Number of observations of each type of Class 1 data. |

| Variable Name | Type | Origin | <u>I/O</u> | Description |
|------------------|------|--------|------------|--|
| BIAS1 | R*4 | CS | I/O | On input essential estimate of biases for each type of Class 1 data (the value 9999999. indicates that no bias is to be determined for the corresponding angle type). On output final bias results. |
| BBND1 | R*4 | CS | I | Convergence bounds for BIAS1 elements. |
| RHOST1 | R*4 | CS | O | Class 1 statistics defined as: RHOST1 (1, I) - weighted sum of angle residuals for type I data RHOST1 (2, I) - weighted sum of squares of angle residuals for type I data RHOST1 (3, I) - sum of weights for type I data RHOST1 (4, I) - mean residual for type I data RHOST1 (5, I) - standard devia- tion for type I data. |
| RHO1 | R*4 | CS | O | Residuals for Class 1 data defined as observed minus calculated. |
| CALC1 | R*4 | cs | O | Calculated angles for Class 1 data. |
| SCOEF1 | R*4 | CS | O . | Derivatives of Class 1 angles with respect to state vector elements (dimensioned as NP $x \#$ of observations, where NP = $\#$ of elements in state vector). |
| TIME2 | R*4 | CS | I | Reference times for Class 2, dihedral angle, data |

| Variable Name | Type | Origin | <u>I/O</u> | Description |
|------------------|------|--------|------------|--|
| AXIS2 | R*4 | CS | I | Reference vectors for class 2 data. (Dimension 6 * number of observations, the ith dihedral angle is measured from vector ((1,i), (2,i), (3,i)) to vector ((4,i), (5,i), (6,i)). |
| ANG2 | R*4 | CS | I | Class 2 angles, in degrees (acceptable range (0° - 360°)). |
| WGHT2 | R*4 | CS | I | Weights for Class 2 data. |
| IFRST2 | I*4 | CS | I | Pointers indicating starting positions for each type of class 2 data in the arrays: TIME2, AXIS2, ANG2, and WGHT2. |
| NTYPE2 | I*4 | CS . | I | Number of observations of each type of Class 2 data. |
| BIAS2 | R*4 | CS | I/O | Essential estimate of biases for each type of Class 2 data (the value 9999999, indicates that no bias is to be determined for the corresponding angle type). |
| BBND2 | R*4 | CS | I | Convergence bounds for BIAS2 elements. |
| RHOST2 | R*4 | CS | O | Class 2 statistics defined as: RHOST2 (1, I) - weighted sum of angle residuals for type I data RHOST2 (2, I) - weighted sum of squares of angle residuals for type I data RHOST2 (3, I) - sum of weights for type I data RHOST2 (4, I) - mean residual for type 2 data RHOST2 (5, I) - standard deviation for type I data. |
| | | • | | |

| Variable <u>Name</u> | Type | Origin | <u>I/O</u> | Description |
|-------------------------|------|--------|------------|---|
| RHO2 | R*4 | CS | 0 | Residuals for Class 2 data defined as observed minus calculated. |
| CALC2 | R*4 | CS | 0 | Calculated angles for Class 2 data. |
| SCOEF2 | R*4 | CS | 0 | Derivatives of Class 2 angles with respect to state vector ele- ments. (Dimensioned as NP x # of observations, where NP = number of elements in the state vector.) |
| AVGRHO | R*4 | CS | O | Used to store magnitude of average residual (dimensioned 2 x 5). |
| COEF | R*4 | CS | 0 | Array used for coefficient, covariance, and correlation matricies. (Dimensioned NS x NS, where NS = number of elements in state vector.) |
| DRHOSQ | R*4 | cs | O | Work array (dimensioned 13). |
| CHNG | R*4 | CS | 0 | Work array used to store the updates to the state vector after each iteration (dimensioned 13). |
| STOR1 | R*4 | CS | O | Work array (dimensioned 13). |
| STOR2 . | R*4 | cs | O . | Work array (dimensioned 13). |
| ALPR | R*4 | CS | O. | Right ascension (ALP) coefficients, in radians. |
| DELR | R*4 | CS | О | Declination (DEL) coefficients, in radians. |

| Variable Name | Туре | Origin | <u>1/O</u> | Description |
|------------------|------|--------|------------|---|
| STYPE1 | R*4 | CS | 0 | Alpha-numeric work array (dimensioned 13). |
| STYPE2 | R*4 | CS | 0 | Alpha-numeric work array (dimensioned 13). |
| BTYPE | I*4 | CS | O | Work array (dimensioned 13). |
| RL | L*1 | CS | О | Logical work array (dimensioned 13). |
| WORK | R*4 | CS | Ο. | Work array (dimensioned 13). |
| GWORK0 | R*8 | CS | O , | Alpha-numeric work array used to store final summary results for display (must be dimensioned as 224). |
| GWORK4 | R*4 | CS | 0 | Work array used to store observa- tion number for plotting (dimen- sioned as N, where N = number of observations, or may be zero). |
| GWORK5 | R*4 | CS | O | Work array used to store (O-C) residuals for plotting (dimensioned as N, where N = number of observations or may be zero). |
| B11CUM | R*8 | CS | O | Alpha-numeric work array used to store cumulative biases for display (must be dimensioned as 105). |
| OPTION | I*4 | DCSOPT | I/O | Flag array for plotting options = 0, do not plot = 1, plot |
| FINISH | I*4 | DCSOPT | I/O | Flag for terminating plot option table = 0, do not terminate = 1, terminate |
| FINALD | I*4 | DCSOPT | I/O | Flag for displaying summary display = 0, do not display = 1, display |

| Variable <u>Name</u> | Type | Origin | <u>I/O</u> | Description |
|-------------------------|------|--------|------------|---|
| TUOI | I*4 | GCN1 | I | FORTRAN device unit for specified printout. |
| NCLAS1 | I*4 | GCN1 | I | Number of Class 1 data types. |
| NC LAS2 | I*4 | GCN1 | I | Number of Class 2 data types. |
| NCOF | I*4 | GCN1 | I | Number of polynomial coefficients for ALP and DEL (range: $1-4$). |
| MAXIT | I*4 | GCN1 | I | Maximum number of iterations. |
| IRWT | I*4 | GCN1 | I | Intermediate printout level indicator (see references for various levels). |
| IOC | I*4 | GCN1 | I | Residual storage indicator = 0, do not store residuals = 1, store residuals for display and plotting. |
| ICALC | I*4 | GCN1 | | Calculated values storage indicators = 0, do not store calculated values = 1, store calculated values for display. |
| SMULT | R*4 | GCN1 | I | Residual edit criteria (the weights of angles whose magnitude of residual is greater than SMULT * (average of residual magnitudes) is set to the negative of the residual thus deleting them. |
| NP | I*4 | GCN1 | I | Total number of elements in the state vector. (Defined as 2 * NCOF + number of biases.) |
| ISTEP | I*4 | GCN1 | 0 | Current iteration indicator. |

| Variable <u>Name</u> | Type | Origin | <u>I/O</u> | Description |
|-------------------------|------|--------|------------|---|
| RET | I*4 | GCN1 | 0 | Return code = 0, process converged = 1, MAXIT exceeded, process terminated = 2, process diverged, correction element > 360° = 3, singular matrix = 4, number of biases > 5 = 5, NCOF out of range |
| CORMIN | I*4 | GCN1 | 0 | Display indicator for Class 1 data = 0, do not display = 1, display |
| CORMAX | I*4 | GCN1 | 0 | Display indicator for Class 2 data = 0, do not display = 1, display |
| IOPEN | I*4 | MASCON | 1 | Graphics device indicator = 0, no graphics device active = 1, MSAD graphics device active |
| OLDALP | R*4 | STVECT | 0. | Current value of ALP before iteration update. |
| OLDDEL | R*4 | STVECT | О | Current value of DEL before iteration update. |
| OLDBS1 | R*4 | STVECT | O | Current value of BIAS1 before iteration update. |
| OLDBS2 | R*4 | STVECT | O | Current value of BIAS2 before iteration update. |
| NEWALP | R*4 | STVECT | O . | Value of ALP after iteration update. |

| Variable <u>Name</u> | Type | Origin | <u>I/O</u> | Description |
|-------------------------|------|--------|------------|--|
| NEWDEL | R*4 | STVECT | 0 | Value of DEL after iteration update. |
| NEWBS1 | R*4 | STVECT | 0 | Value of BIAS1 after iteration update. |
| NEWBS2 | R*4 | STVECT | O | Value of BIAS2 after iteration update. |

| Name | Read/Write/Check | Description |
|----------|------------------|---|
| FTXXFOO1 | Write | Intermediate printout, where XX = IOUT |
| GCONE0 | Check | DCCONS initial parameter display |
| DCC1 | Check | Class 1 data display |
| DCC2 | Check | Class 2 data display |
| OPTAB1 | Check | Option table display |

RESTRICTIONS:

- 1 The number of polynominal coefficients must be greater than or equal to 1 and less than or equal to 4.
- 2 The number of biases determined, for both Class 1 and Class 2 data, must be less than or equal to 5.
- 3 All calling sequence arrays are MSAD allocated, and hence, it is up to the user to ensure the allocation size of the arrays is not exceeded.

SUBROUTINE COFSM

CALLING SEQUENCE: CALL COFSM (TIME, AXIS, ANG, WGHT, NUMB, ITYPE, NDIM, ALPR, DELR, BIAS, IBIAS, COEF, DRHOSQ, RHOST, RH, CALC, SCOEF, JONE)

DESCRIPTION:

COFSM is similar to the GCONES routine COFSUM with the following added features: calculated values can be stored, derivatives can be stored, residuals can be stored.

COMMON AREAS REFERENCED:

GCN1

EXTERNAL REFERENCES:

ABS, COS, SIN

STORAGE REQUIREMENTS: 4884 bytes

| Variable Name | Type | Origin | <u>I/O</u> | Description |
|------------------|------|--------|------------|--|
| TIME | R*4 | CS | I | Array of observation times. |
| AXIS | R*4 | CS | I | Reference vectors (dimensioned NDIM x (# of observations)). |
| ANG | R*4 | CS | I | Observed angles, in degrees. |
| WGHT | R*4 | CS | I/O | Weights for observed data. |
| NUMB | I*4 | CS | I | Number of observations for class and type being processed. |
| ITYPE | I*4 | CS | I | The class of data being processed. |
| NDIM | I*4 | CS | I | Indicator for class reference vectors = 3, for Class 1 data = 6, for Class 2 data (i.e., NDIM = 3 * (number of reference vectors required to define ANG)). |
| ALPR | R*4 | CS | I . | Right ascension coefficients, in radians. |

| Variable Name | Type | Origin | <u>I/O</u> | Description |
|------------------|------|--------|------------|---|
| DELR | R*4 | CS | I | Declination coefficients, in radians. |
| BIAS | R*4 | CS | I | Bias for class and type of data being processed. |
| IBIAS | I*4 | CS | I | Index to indicate bias under consideration. |
| COEF | R*4 | CS | o | Vector [H]' [W] ρ , where H is derivative matrix, W is weight matrix, ρ is the residual vector. (i.e., right side vector of simultaneous equations.) |
| RHOST | R*4 | CS | O | Statistics: RHOST(1) - weighted sum of residuals RHOST(2) - weighted sum of squares of residuals RHOST(3) - sum of weights RHOST(4) - mean residuals RHOST(5) - standard deviations |
| RH | R*4 | CS | 0 | Vector of residuals. |
| CALC | R*4 | CS | 0 | Vector of calculated values. |
| SCOEF | R*4 | CS | 0 | Matrix of partial derivatives (dimensioned number of elements in state vector x number of observations). |
| JONE | I*4 | CS | I | Index indicating starting location of data in arrays TIME, AXIS, ANG, WGHT, RH, CALC, SCOEF for the class and type of data being processed. |
| IOUT | I*4 | GCNI | I | Fortran device unit for specified printout. |

| Variable Name | $\frac{\text{Type}}{}$ | Origin | <u>I/O</u> | Description |
|------------------|------------------------|--------|------------|---|
| NCOF | I*4 | GCN1 | Ι | Number of polynomial coefficients for ALP and DEL |
| IRWT | I*4 | GCŅ1 | I | Intermediate printout level indi- cator (see reference 1). |
| TZERO | R*4 | GCN1 | I | Reference time. |
| IOC | I*4 | GCN1 | Ĭ | Residual storage indicator = 0, do not store residuals = 1, store residuals for display and plotting |
| ICALC | I*4 | GCN1 | Ĭ | Calculated values storage indi- cator = 0, do not store calculated values = 1, store calculated values for display |

| Name | Read/Write/Display | Description |
|----------|--------------------|--|
| FTXXFOO1 | Write | Intermediate printout, where XX = IOUT |

SUBROUTINE BLKINV

CALLING SEQUENCE: CALL BLKINV (COEF, I, J, NP, DET, IERR, STOR1, STOR2, RL)

DESCRIPTION:

 BLKINV inverts a symmetric block diagonal matrix using a maximum pivot strategy.

COMMON AREAS REFERENCED:

None

EXTERNAL REFERENCES:

ABS

STORAGE REQUIREMENTS: 1408 bytes

VARIABLES:

| Variable <u>Name</u> | Type | Origin | <u>I/O</u> | Description |
|-------------------------|------|--------|------------|--|
| COEF | R*4 | CS | I/O | Symmetric matrix containing block to be inverted. On return, COEF contains inverted block. |
| I | I*4 | cs | Ι | Starting row and column of block to be inverted. |
| J | I*4 | CS | I. | Stopping row and column of block to be inverted. |
| NP | I*4 | cs | I | Size of the square matrix COEF (dimension of COEF is NP x NP). |
| DET | R*4 | CS | О | Value of the determinant. |
| IERR | I*4 | CS | 0 | Error code = 0, normal return = 1, zero pivot element, inverse cannot be obtained |
| STOR1 | R*4 | cs | O | Work array (size of NP or larger). |
| STOR2 | R*4 | CS | O | Work array (size of NP or larger). |
| RL | L*1 | cs | О | Work array (size of NP or larger). |

SUBROUTINE GSTAT1

CALLING SEQUENCE: CALL GSTAT1 (ALP, ALPBND, ALPCUM, DEL, DELBND, DELCUM, ARGCUM, TIME1, AXIS1, ANG1, WGHT1, IFRST1, NTYPE1, BIAS1, BBND1, RHOST1, RHO1, CALC1, SCOEF1, TIME2, AXIS2, ANG2, WGHT2, IFRST2, NTYPE2, BIAS2, BBND2, RHOST2, RHO2, CALC2, SCOEF2, AVGRHO, COEF, DRHOSQ, CHNG, STOR1, STOR2, ALPR, DELR, STYPE1, STYPE2, BTYPE, RL, WORK, B11CUM)

DESCRIPTION:

GSTAT1 stores cumulative iteration results for displaying and performs residual editing on the data.

COMMON AREAS REFERENCED:

FLAGG, GCN1, GDCON

EXTERNAL REFERENCES:

ABS, CHECK, INCORE, PTSIZE

STORAGE REQUIREMENTS: 5400 bytes

| Variable Name | $\underline{\text{Type}}$ | Origin | <u>I/O</u> | Description |
|------------------|---------------------------|--------|------------|--|
| ALP | R*4 | CS | I | A priori polynomial coefficients for right ascension, in degrees. |
| ALPBND | R*4 | CS. | I | Convergence bounds for ALP, in degrees. |
| ALPCUM | R*4 | CS | O 22 | Cumulative results for ALP(1) (dimensioned as 21). |
| DEL | R*4 | CS | I | A priori polynomial coefficients for declination, in degrees. |
| DELBND | R*4 | CS | I | Convergence bounds for DEL, in degrees. |
| DELCUM | R*4 | CS | Ο ` | Cumulative results for DEL(1) (dimensioned as 21). |
| ARGCUM | I*4 | CS | 0 ' | Iteration indicator for values in ALPCUM and DELCUM (dimensioned as 21). |
| TIME1 | R*4 | CS | I | Reference times for Class 1 (cone angle) data. |

| Variable Name | Type | Origin | <u>I/O</u> | Description |
|------------------|------|--------|------------|---|
| AXIS1 | R*4 | CS | I | Reference unit vectors for Class 1 data (dimensioned 3 * number of Class 1 observations). |
| ANG1 | R*4 | CS | I | Class 1 (cone angle) observations, in degrees. |
| WGHT1 | R*4 | CS | I/O | Class 1 weights. |
| IFRST1 | I*4 | cs | I | Pointers indicating starting positions for each type of Class 1 data in the arrays: TIME1, AXIS1, ANG1, WGHT1. |
| NTYPE1 | I*4 | cs | I | Number of observations of each type of Class 1 data. |
| BIAS1 | R*4 | CS | I | Essential estimate of biases for each type of Class 1 data. |
| BBND1 | R*4 | cs | I | Convergence bounds for BIAS1 elements. |
| RHOST1 | R*4 | CS | I . | Class 1 statistics defined as: RHOST1(1, I) - weighted sum of angle residuals for type I data RHOST1(2, I) - weighted sum of squares of angle residuals for type I data RHOST1(3, I) - sum of weights for type I data RHOST1(4, I) - mean residuals for type I data RHOST1(5, I) - standard deviations for type I data. |
| RHO1 | R*4 | CS | I | Residuals for Class 1 data de- fined as observed minus calculated. |
| CALC1 | R*4 | CS | r | Calculated angles for Class 1 data. |

| Variable <u>Name</u> | Type | Origin | I/O | Description |
|-------------------------|------|--------|-----|---|
| SCOEF1 | R*4 | CS | I | Derivatives of Class 1 angles with respect to state vector elements (dimensioned as NP * number of observations where NP = number of elements in the state vector). |
| TIME2 | R*4 | CS | I | Reference times for Class 2, dihedral angle, data. |
| AXIS2 | R*4 | CS | I | Reference vectors for Class 2 data (dimensioned 6 x number of observations. The ith dihedral angle is measured from vector ((1,i), (2,i), (3,i)) to vector ((4,i), (5,i), (6,i)). |
| ANG2 | R*4 | CS | I | Class 2 angles, in degrees. |
| WGHT2 | R*4 | CS | I/O | Weights for Class 2 data. |
| IFRST2 | I*4 | CS · | I | Pointers indicating starting positions for each type of Class 2 data in the arrays: TIME2, AXIS2, ANG2, WGHT2. |
| NTYPE2 | I*4 | CS | Ţ | Number of observations of each type of Class 2 data. |
| BIAS2 | R*4 | CS | I . | Essential estimate of biases for each type of Class 2 data. |
| BBND2 | R*4 | CS | I | Convergence bounds for BIAS2 elements. |
| RHOST2 | R*4 | CS | I . | Class 2 statistics defined as: RHOST2(1, I) - weighted sum of angle residuals for type I data RHOST2(2, I) - weighted sums of squares of angle residuals for type I data |

| Variable Name | Туре | Origin | <u>I/O</u> | Description |
|------------------|------|--------|------------|--|
| RHOST2 | R*4 | CS | I | RHOST2(3, I) - sum of weights for type I data RHOST2(4, I) - mean residuals for type I data RHOST2(5, I) - standard deviations for type I data. |
| RHO2 | R*4 | CS | I | Residuals for Class 2 data defined as observed minus calculated. |
| CALC2 | R*4 | CS | I | Calculated angles for Class 2 angles. |
| SCOEF2 | R*4 | CS | I | Derivatives of Class 2 angles with respect to state vector elements (dimensioned as NP x $\#$ of observations, where NP = number of elements in state vector). |
| AVGRHO | R*4 | CS | О | Used to store magnitude of average residual (dimensioned 2×5). |
| COEF | R*4 | cs | I . | Array used for coefficient, covariance, and correlation matrices (dimensioned NS x NS, where NS = number of elements in state vector). |
| DRHOSQ | R*4 | CS | I | Work array (dimensioned 13). |
| CHNG | R*4 | CS | I | Work array used to store the updates to the state vector after each iteration (dimensioned 13). |
| STOR1 | R*4 | CS | Ţ | Work array (dimensioned 13). |
| STOR2 | R*4 | CS | I | Work array (dimensioned 13). |
| ALPR | R*4 | CS | I | Right ascension (ALP) coefficients, in radians. |

| Variable Name | Type | Origin | <u>I/O</u> | Description |
|------------------|------|--------|------------|---|
| DELR | R*4 | CS | I . | Declination (DEL) coefficients, in radians. |
| STYPE1 | R*4 | CS | 1 | Alpha-numeric work array (dimensioned 13). |
| STYPE2 | R*4 | CS | I | Alpha-numeric work array (dimensioned 13). |
| BTYPE | I*4 | CS | I . | Work array (dimensioned 13). |
| RL | L*1 | CS | I | Work array (dimensioned 13). |
| WORK | R*4 | CS | I | Work array (dimensioned 13). |
| B11CUM | R*8 | CS | 0 | Alpha-numeric work array used to store cumulative biases for display (dimensioned as 105). |
| IOUT | I*4 | GCN1 | I . | Fortran device unit for specified output. |
| NC LAS1 | I*4 | GCN1 | I · | Number of class 1 data types. |
| NCLAS2 | I*4 | GCN1 | . I | Number of Class 2 data types. |
| IRWT | I*4 | GCN1 | Í | Intermediate printout level indicator (see Reference 1 for various levels). |
| IÓC | I*4 | GCN1 | . I | Residual storage indicator = 0, do not store residuals = 1, store residuals for display and plotting. |
| SMULT | R*4 | GCN1 | I | Residual edit criteria (the weights of angles whose magnitude of residual is greater than SMULT * (average of residual magnitude) is set to the negative of the residual thus deleting them from the differential correction process. |

| Variable <u>Name</u> | Type | Origin | <u>I/O</u> | Description |
|-------------------------|------|--------|------------|--|
| ISTEP | I*4 | GCN1 | I | Current iteration indicator. |
| AVG | R*4 | GDCON | 0 | Residual edit bound (i.e., average residual for Class 1 and Class 2 data). |

| Name | Read/Write/Check | Description |
|----------|------------------|---|
| FTXXFØØ1 | Write | Intermediate printout, where XX = IOUT. |
| GSTATA | Check | Cumulative state vector display. |
| GSTAT1 | Check | Residual edit data display. |

SUBROUTINE FINAL2

CALL SEQUENCE: CALL FINAL2 (GWORKO, ALP, DEL, AI, DI, BIASI, BIAS1, BIAS2I, BIAS2, RHOST1, RHOST2, NTYPE1, NTYPE2, NCOF, IALLO, COVAR, NC)

DESCRIPTION:

FINAL2 converts the initial and current iteration values of the state vector into alpha-numeric characters for the summary display.

COMMON AREAS REFERENCED:

None

EXTERNAL REFERENCES:

INCORE, PTSIZE, SQRT

STORAGE REQUIREMENTS: 4224 bytes

| Variable <u>Name</u> | Type | Origin | <u>I/O</u> | Description |
|-------------------------|-------|--------|------------|---|
| GWORK0 | . R*8 | CS | 0 | Work array where alpha-numeric equivalents of previous and current values of the state vector are stored. |
| ALP | R*4 | CS | I | Right ascension polynomial coef- ficients, in degrees. |
| DEL | R*4 | CS ' | I | Declination polynomial coefficients, in degrees. |
| AI | R*4 | CS | Ι . | Initial right ascension polynomial coefficients, in degrees. |
| DI | R*4 | CS | I | Initial declination polynomial coefficients, in degrees. |
| BIASI | R*4 | CS | I . | Initial biases for each type of Class 1 data, in degrees. |
| BIAS1 | R*4. | CS | I | Biases for each type of Class 1 data, in degrees. |
| BIAS2I | R*4 | CS | I | Initial biases for each type of Class 2 data, in degrees. |
| BIAS2 | R*4 | CS | I | Biases for each type of Class 2 data, in degrees. |
| RHOST1 | R*4 | CS | I | Class 1 statistics (see DCCONS module description for RHOST1 (1, I) - RHOST1(3, I)) RHOST1(4, I) - mean residual for type I data RHOST1(5, I) - standard deviation for type I data. |

| Variable Name | Type | Origin | <u>I/O</u> | Description |
|------------------|------|--------|------------|--|
| RHOST2 | R*4 | CS | I | Class 2 statistics (see DCCONS module description for RHOST2 (1, I) - RHOST2 (3, I)) RHOST2 (4, I) - mean residual for type I data RHOST2 (5, I) - standard deviation for type I data. |
| NTYPE1 | I*4 | CS | I | Number of Class 1 data types. |
| NTYPE2 | I*4 | CS | I | Number of Class 2 data types. |
| NCOF | I*4 | CS | 1 | Number of polynomial coefficients for ALP and DEL. |
| IALL0 | I*4 | CS | 1 | Allocation size for GWORK0 array (must be 224). |
| COVAR | I*4 | CS | I | Covariance matrix for state vector elements. |
| NC | I*4 | cs | I | Number of elements in the state vector. |

SUBROUTINE GDCCON

CALLING SEQUENCE: CALL GDCCON (IALI4, IALI5, IFRST1, IFRST2, NTYPE1, NTYPE2, RHO1, RHO2, GWORK4, GWORK5, IALI0)

DESCRIPTION:

GDCCON stores the computed residuals for plotting into work arrays and calls the MSAD related tables to display the plots.

COMMON AREAS REFERENCED:

DCSOPT, GCN1

EXTERNAL REFERECES:

CHECK, PTSIZE

STORAGE REQUIREMENTS: 1786 bytes

| Variable Name | Type | Origin | <u>I/O</u> | Description |
|------------------|------|--------|------------|---|
| IALIA | I*4 | CS | I | Allocation size of GWORK4 array. |
| IA LL5 | I*4 | CS | I | Allocation size of GWORK5 array. |
| IFRST1 | I*4 | CS | I | Pointers indicating starting positions for each type of Class 1 data in the RHO1 array. |
| IFRST2 | I*4 | CS | I | Pointers indicating starting positions for each type of Class 2 data in the RHO2 array. |
| NTYPE1 | I*4 | CS | I | Number of observations of each type of Class 1 data. |
| NTYPE2 | I*4 | CS | Ι. | Number of observations of each type of Class 2 data. |
| RHO1 | R*4 | CS ' | I | Residuals for Class 1 data defined as observed minus calculated. |
| RHO2 | R*4 | CS | I | Residuals for Class 2 data defined as observed minus calculated. |
| GWORK4 | R*4 | CS | 0 | Work array for storage of observation numbers for each class and type of data (dimensioned as # of observations). |
| GWORK5 | R*4 | CS | O | Work array for storage of residuals for each class and type of data (dimensioned as number of observations). |
| IALLO | I*4 | CS | I | Allocation size of GWORKO (must be 224 or 0). |

| Variable Name | Туре | Origin | <u>I/O</u> | Description |
|------------------|------|--------|------------|--|
| OPTION | I*4 | DCSOPT | I/O | Flag array for plotting options = 0, do not plot = 1, plot |
| FINISH | I*4 | DCSOPT | I/O | Flag for terminating plot option table = 0, do not terminate = 1, terminate |
| FINALD | I*4 | DCSOPT | I/O | Flag for displaying summary display = 0, do not display = 1, display |
| NC LAS1 | I*4 | GCN1 | I | Number of Class 1 data types. |
| NC LAS2 | I*4 | GCN1 | I | Number of Class 2 data types. |
| IOC | I*4 | GCN1 | | Residual storage indicator = 0, do not store residuals = 1, store residuals for display and plotting |

| Name | Read/Write/Check | Description |
|--------|------------------|--|
| DRES11 | Check | Residual plot for Class 1 type 1 data. |
| DRES12 | Check | Residual plot for Class 1 type 2 data. |
| DRES13 | Check | Residual plot for Class 1 type 3 data. |
| DRES14 | Check | Residual plot for Class 1 type 4 data. |
| DRES15 | Check | Residual plot for Class 1 type 5 data. |

| Name | Read/Write/Check | Description |
|--------|------------------|--|
| DRES21 | Check | Residual plot for Class 2 type 1 data. |
| DRES22 | Check | Residual plot for Class 2 type 2 data. |
| DRES23 | Check | Residual plot for Class 2 type 3 data. |
| DRES24 | Check | Residual plot for Class 2 type 4 data. |
| DRES25 | Check | Residual plot for Class 2 type 5 data. |
| DFINDP | Check | Summary display |
| OPTAB1 | Check | Plot option table display |

SECTION 3 RESOURCES

The DCCONS subsystem is designed to operate under the Multi-Satellite Attitude Determination (MSAD) system on either the IBM 360/75, 360/91, or 360/95.

3.1 Environment

DCCONS is a differential correction routine which minimizes the weighted sum of residuals squared between measured and computed angles to obtain corrections to the state vector through the facility of interactive graphics. The MSAD Executive system provides the interactive capabilities through a graphics display device. The operator can edit control parameters and data via the display device, thereby enhancing the otherwise noninteractive flow of the program.

3.1.1 Hardware Requirements

Hardware requirements for the DCCONS subsystem are as follows:

- Input:
 - none
- Output:
 - one line printer
 - one 2250 or 2260 graphics display unit
 - one tape drive (optional, if hard copy of the MSAD plots is required)

3.1.2 Storage Requirements

The DCCONS subsystem requires 32.5 K bytes of core storage on the IBM System/360-95 to operate in a graphics mode. Due to the dynamic allocation feature of the MSAD system, this figure does not include the allocation sizes of the work arrays which are user determined, nor does this figure include the amount of core storage required to store the DCCONS graphics tables.

3.2 Software Requirements

The DCCONS subsystem is written in the FORTRAN IV programming language, currently operational on OS Release 21.6. The following external libraries are assessed by DCCONS:

- IBM System/360 FORTRAN IV Library Subprograms
- Multi-Satellite Attitude Determination (MSAD) Executive System User's Guide (Ref. 14)

SECTION 4 INPUT

All user supplied input is passed to the DCCONS subsystem through the use of calling sequences and labeled COMMON areas. For a definition of input parameters, refer to Section 2, Module Descriptions.

The user may also alter control parameters and data through the interactive graphics facility. For a discussion of this feature, refer to Section 5, Graphics Output.

SECTION 5 GRAPHICS DISPLAYS

This section describes all the graphics displays generated by the DCCONS subsystem. These displays are designed to aid an operator at a 2250 graphics terminal in the immediate determination of attitude solutions and to insure data consistency. Controlled by user option, these displays permit an operator to alter the initial state vector variable estimates and variable error tolerances, to review input cone and dihedral angles with their associated weights and times, to observe the cumulative iteration results for each state vector update, to review the calculated residuals and to alter any, if needed, to choose observed minus computed (O-C) residual plots for observation, and to view the summary of the state vector updates for each iteration.

Several general comments should be noted. Each display is associated with an MSAD table which is called from the DCCONS sub-system. In accordance with the MSAD conventions, any display not required in a given pass through the data may be omitted by setting the status flag of the display control point to SKIP in the MSAD ARTCMM display. See Figure 5-1 for a list of all DCCONS related control point display names. The dimensions of all MSAD allocated arrays are user controlled; hence, the operator can alter the master numbers of all internal arrays via the MSAD XSTOPS display. See Figure 5-2 for an illustration of the available DCCONS arrays. In addition, the user has the opportunity to request any display from any display screen via the MSAD automatic call mechanism. The user should be cautioned that a display thus called will contain current information only if the display has been previously created within the same iteration as the display from which the call has been issued.

Short descriptions of the functions and options of the DCCONS displays are provided in this section. In addition, an illustration of the display as it would appear on the IBM 2250 graphics console is provided for user correlation.

5.1 DCCONS Coefficients and Parameters Display

This display permits an operator at the IBM 2250 console to observe the initial attitude estimates and the initial program tolerances, to alter these values through the IBM 2250 graphics display keyboard, and to redisplay them on the 2250 unit.

The DCCONS coefficients and parameter display consists of three groups. The first group contains the DCCONS control parameters (i.e., number of alpha/delta coefficients, maximum number of iterations, printed output level, printer unit, numbers of class 1 and class 2 data types, system reference time, residual edit criteria, and the number of elements in the state vector). If the number of alpha/delta coefficients, the numbers of class 1 and class 2 data types, or the

number of biases to be solved (see group three) are altered, the number of elements in the state vector must also be altered to coincide. If this number has not been altered, the original display will reappear. When the numbers coincide, the augmented or deleted display will appear for user input into the third group.

The second group consists of option parameters. These options permit the operator to choose which data, if any, is pertinent for display purposes. If the user requests the storage of residuals for plotting, the DCCONS residuals plot arrays must be allocated. If this option is turned off, the operator cannot request any residual plots. The "store computed values for display" option allows the operator to observe the calculated angles. If this option is not activated, a series of EEEEEEE's will appear in the 'CALCULATED VALUES' column of the RESIDUALS and WEIGHTS display (see sections 5.6 and 5.7). The final option in this group permits the operator to review and edit class 1 and/or class 2 data.

The third group consists of the initial state vector estimates and convergence bounds. The user can alter any or all of the values present. To disregard a bias associated with a particular class and type of data, the number 9999999.0 should be entered into the bias slot. If the number of state parameter values has been previously altered, this third group will be changed to reflect the alteration. The user then should input into the variable slots.

Figure 5.3 illustrates the DCCONS Coefficients and Parameters Displays.

5.2 DCCONS Observed Data — Class 1

This display permits an operator at the IBM 2250 graphics console to observe all class 1 (cone angle) data input. The values displayed (i.e., time of observation, reference vector, cone angle, weight) can be altered by the user.

To obtain this display, the operator can either enter a YES into the 'EDIT CLASS 1 DATA' parameter, or he can exercise the MSAD automatic call mechanism and CALL this display (DC11) from any other MSAD display.

Figure 5-4 illustrates the DCCONS Observed Data — Class 1 Display

5.3 DCCONS Observed Data — Class 2

This display permits an operator at the IBM 2250 graphics console to observe all Class 2 (dihedral angle) data input. The values displayed (i.e., time of observation, reference vector, dihedral angle, weight) can be altered by the user.

To obtain this display, the operator can either enter a YES into the 'EDIT CLASS 2 DATA' parameter, or he can exercise the MSAD automatic call mechanism and CALL this display (DC22) from any other MSAD display.

Figure 5-4 illustrates the DCCONS Observed Data -Class 1 Display.

5.3 DCCONS Observed Data — Class 2

This display permits an operator at the IBM 2250 graphics console to observe all Class 2 (dihedral angle) data input. The values displayed (i.e., time of observation, reference vector, dihedral angle, weight) can be altered by the user.

To obtain this display, the operator can either enter a YES into the 'EDIT CLASS 2 DATA' parameter, or he can exercise the MSAD automatic call mechanism and CALL this display (DC22) from any other MSAD display.

Figure 5-5 illustrates the DCCONS Observed Data - Class 2 Display.

5.4 Error Statistics Display

This display allows the user at the 2250 graphics console to observe the computed mean residuals and standard deviations for each class and type of data being proceed. This display can either be obtained by setting the status flag of the display (DCCONS RESIDUAL STATISTICS) to 'STOP', or it can be CALLed via the MSAD automatic call mechanism from any subsequent display (see Sections 5.5, 5.6, 5.7, 5.8, 5.9) within the same iteration.

Figure 5-6 illustrates the Error Statistics Display.

5.5 Cumulative State Vector Display

This display allows an operator at the IBM 2250 graphics console to observe, on an iteration by iteration basis, the updates to the state vector. The purpose of this display is to permit the operator to respond to any gross alteration in the state vector values. This display can either be obtained by setting the status flag of the display (DCCONS CUMULATIVE STATE RESULTS) to 'STOP', or it can be obtained by issuing a CALL via the MSAD automatic call mechanism from any subsequent display (see Sections 5.6, 5.7, 5.8, 5.9) in the same iteration.

Figure 5-7 illustrates the Cumulative State Vector Display.

5.6 Class 1 Residuals and Weights

This display permits an operator at a 2250 graphics console to observe the calculated residuals (observed minus computed) and their associated weights. The user has the option to alter any of the angle weights. If a negative weight is associated with an input angle, that data has been edited by the residual edit feature of

DCCONS. Those angles so edited will not be included in the current and subsequent calculations of the state vector updates, and will not appear in any of the (O-C) residual plots. If the user manually edits the data, the data so edited will included in the current iteration, but will be disregarded by subsequent iterations.

The residuals will only be displayed if the 'STORE RESIDUALS FOR PLOTTING' in the DCCONS COEFFICIENTS AND PARAMETERS Display (see Section 5.1)

Figure 5-8 illustrates the Class 1 Residuals and Weights.

5.7 Class 2 Residuals and Weights

The display permits an operator at a 2250 graphics console to observe the calculated residuals (observed minus computed) and their associated weights. The user has the option to alter any of the angle weights. If a negative weight is associated with an input angle, that data has been edited by the residual edit feature of DCCONS. Those angles so edited will not be included in the current and subsequent calculations of the state vector updates, and will not appear in any of the (O-C) residual plots. If the user manually edits the data, the data so edited will be included in the current iteration, but will be disregarded by subsequent iterations.

The residuals will only be displayed if the 'STORE RESIDUALS FOR PLOTTING' in the DCCONS COEFFICIENTS AND PARAMETERS Display (see Section 5.1)

Figure 5-9 illustrates the Class 2 Residuals and Weights.

5.8 Plot Option Table for DCCONS Display

This display permits an operator at an IBM 2250 graphics console to observe the status of DCCONS and to choose (O-C) residual plots for observation.

The PLOT OPTION TABLE consists of three groups. The first group reports on the status of DCCONS at the current iteration. If 'DID DCCONS CONVERGE?' is set to 'NO', and all other status' are 'NO', then the user has the option to continue processing, to terminate, or to reprocess. If any of the other status questions are answered with a 'YES', the user has the option of terminating or reinitializing. If neither of these options (see group three) is chosen, then the termination of the display will result in the termination of DCCONS processing. This group is protected and cannot be altered by the user.

The second group consists of a list of plots available for user inspection and the attitude summary display option. The user may choose any plot, and/or the

summary display by typing in 'YES' into the associated field. Any number of plots may be chosen, but the plots will appear in the order listed in the PLOT OPTION TABLE Display. If the user does not require any of the displays offered, and all of the status' in group one are set to 'NO' the operator can 'SKIP' out of PLOT OPTION TABLE Display. If, however, any display is requested or if any of the status' in group one is set to 'YES', the user must request termination of the PLOT OPTION TABLE Display (see group three). If this option is not set, the PLOT OPTION TABLE Display will continue to appear until this option has been set to 'NO' by the user.

The third group consists of options available to the user. The user may terminate DCCONS processing from this display; he may reinitialize DCCONS processing; or he may allow the program to flow normally by not setting any of the above options. Included in this third group is the option to 'EXIT THE PLOT OPTION TABLE'. When the user is finished observing a particular iteration of data, the user must set the exit option to 'YES'. DCCONS will continue processing the next iteration, or it will process according to the options in group three.

Figure 5-10 illustrates the PLOT OPTION TABLE.

5.9 Final State Vector Results from DCCONS Display

This display allows an operator at an IBM 2250 console to view the initial and intermediate iteration state vector values plus the mean residuals and standard deviations for each type and class of data.

The display can only be observed if the appropriate field in the PLOT OPTION TABLE (see Section 5.8, SUMMARY DISPLAY) is set to 'YES'.

Figure 5-11 illustrates the FINAL STATE VECTOR RESULTS FROM DCCONS Display.

```
XSTORS
                         DISPLAY STATUS FLAGS AND KEY ASSIGNMENTS
         ASTORE DISPLAY
                                                  STOP
                                                  STOP
         ARTCCH DISPLAY
**
         CCCCNS INITIAL CONDITIONS AND ESTIMATE
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         EDIT CLASS 1 DATA WEIGHTS
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         EDIT CLASS 2 DATA WEIGHTS
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         CCCENS RESIDUAL STATISTICS
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         ECCONS CUMULATIVE STATE RESULTS
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         RESIDUAL CLASS I TYPE I STOP DISPLAY
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         RESIDUAL CLASS 1 TYPE 2 STOP DISPLAY
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         RESIGUAL CLASS 1 TYPE 3, STOP DISPLAY
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         RESIDUAL CLASS 1 TYPE 4 STOP DISPLAY
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         RESIDUAL CLASS 1 TYPE 5 STOP DISPLAY
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         RESIDUAL CLASS 2 TYPE 1 STOP DISPLAY
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Figure 5-1

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Figure 5-2

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                                      DISPLAY
                           DCCONS COEFFICIENTS AND PARAMETERS
         NUMBER OF ALPHAZDELTA COEFFICIENTS
         MAXIMUM NUMBER OF ITERATIONS
                                                    55,
**
         PAINTED OUTPUT LEVEL
**
         SYSHUT UNIT FOR COCONS
                                                    \epsilon
         NUMBER OF CLASS 1 DATA TYPES
**
         NUMBER OF CLASS 2 DATA TYPES
*
         PEFERENCE TIME
         RESIDUAL EDIT CRITERIA
                                                    0.0
         NUMBER OF ELEMENTS IN STATE VECTOR
         STORE (O-C) RESIDUALS FOR PLOTTING
* *
         STORE COMPUTED VALUES
                                                  NO.
         COMPUTE COVARIANCE/CORRELATION MATRIX
                                                 No.
         GRAFFICALLY EDIT CLASS 1 DATA
                                                  NO
         CRAFFICALLY EDIT CLASS 2 CATA
**
         ENTER IMITIAL ESTIMATES OF STATE
**
         VECTOR AND CONVERGENCE BRUNDS
**
       ALFHA
               CONVRG
                                          BIASES CONVEG
                         CELTA
                                 CANVOG
                                                           BIASES CENVAG
**
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              BOUNDS
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Figure 5-3

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        CEGINT=DCC11 WHAT NOW
                                   NEXT
                                              CALL DISPLAY
                                                                   DISP
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                                        DISPLAY
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Figure 5-4

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| 5192+398 | -0.946 | -0.297 | -0.129 | 80.95 89.01 | 0.105 | | | |
| £249.996 | -0.946 | -0.297 -0.297 | -0.129 -0.129 | 89.21 | 0.105 | | | |
| 5311.199 | -0.946 | | -0.129 | 88.70 | 0.105 0.10F | | | |
| 5372.398 | -0.946 | -0 €297 | | 86.01 | 0.44F | | | |
| -5368.969 | 0.944 | -0.286 | -0.164 | 89.23 | 0.445 | | | |
| -\$368.180 -5307.746 | 0.944 | -0.285 -0.254 | -0.164 -0.146 | 85.65 | 0.565 | | | |
| | 0.956 | | -0.145 | 82.94 | 0.349 | | , , | |
| -5306.957 | 0.956 | -0.253 | | 85.94 | 0 • 54F | | | |
| -5246.523 | 0.967 | -0.221 | -0.127 | | | | | |
| -5245.734 | 0.967 0.976 | -0.221 -0.191 | -0.127 -0.109 | 81.67 86.51 | 0 • 64F | | | |
| -5168.902 | | -0.191 | -0.109 | 87.11 | 0.46F | | | |
| -5188 • 113 | 0.976 | | | 8A.01 | 0.34 | | | |
| -5127 - 684 | 0.983 | ~0•158 | -0.090 | 89.69 | 0.275 | | | |
| -5126+891 -5066+461 | 0.983 0.990 | -0.158 -0.125 | -0.090 -0.071 | 85.62 | 0.85F | | | |
| | | | -0.071 -0.071 | 84.16 | 0.145 | | | |
| -5065,668 | 0.950 | ~0.125 | -0.053 | 86 • 1 B | 0.14- | - | 4 | |
| -5008.840 | 0.994 | -0.094 | -0.053 | 84.95 | 0.175 | | | • |
| +5GG9.047 | 0.994 | . +0 •093 | | 86.53 | 0 • 1 % T | | | |
| -4947.617 | 0.998 | -0.060 | -0.034 | | 0.125 | | | |
| -4546 828 | | -0.060 | -0.034 | 87.56 | 0.12 | | | |
| -4886.395 | 1.000 | ~0.027 | -0.015 | 87.05 88.98 | 0.845 | | | |
| -4885.605 | 1.000 | -0.026 0.005 | -0.014 0.004 | 87.85 | 0.465 | | | |
| -4828.777 | 1.000 | | | 85.37 | 0.466 0.39F | | | |
| -4827.980 | 1.000 | 0.005 | 0.004 | | 0.986 | | | |
| -4767.851 | 0.999 | 0.038 | 0.023 0.023 | 87.06 87.10 | 0.365 | | | |
| -4765.762 -4766.328 | 0.999 | 0.039 0.072 | 0.042 | 87.59 | 0.88F | | | |
| -47C5.535 | 0.996 | 0.072 | 0.043 | 86.49 | 0.625 | | | |
| -4648.711 | | 0.103 | 0.060 | 87.78 | 0.95 | | | |
| | 0.993 0.993 | 0.103 | 0.061 | 88.02 | 0.418 | | | |
| -4647.918 | | | 0.080 | 86.08 | 0.415 | | | |
| -45£7.488 -45£6.695 | 0.987 0.987 | 0.136 0.136 | 0.080 | 87.27 | 0.125 | | | |
| -4526.266 | 0.981 | 0.150 | 0.059 | 87.65 | 0.225 | | | |
| -4525.400 -4525.473 | 0.981 | 0.169 | 0.099 | 87.68 | 0 • 22¢ | | | |
| -4525.473 -4468.645 | 0.981 | 0.500 | 0.116 | 88.07 | 0.145 | | | |
| -4468.645 -4467.852 | 0.973 | 0.200 | 0.117 | 87.70 | 0.255 | | | |
| · - | | | | | | | | |
| -4407.422 -4406.629 | 0+963 0+963 | 0.232 0.233 | 0.135 0.135 | 88.52 88.36 | 0 • 48F | | | |
| +4400+629 -4346+203 | 0.952 | 0.264 | 0.155 | 68+64 | 0.482 | | | |
| · · · · · · · · · · · · · · · · · · · | • | | | | 0.93F | | | |
| -4345.410 | 0.952 | 0.265 | 0.154 | 88 46 0 | | | | |
| -42E8.582 | 0.940 | 0.294 | 0.171 0.171 | 88.97 89.06 | 0.65F | | | |
| -4287.785 | 0.940 | 0 • 295 | | | | | | |
| -4227.355 | 0.926 | 0.325 | 0.189 | 89.88 | 0.695 | | | |
| -4225.566 | 0.926 | 0.326 | 0.189 | 89.68 | 0.10+ | | | |
| -4166 • 137 | 0.911 | 0.356 | 0.207 | 89.53 | 0.395 | | | |
| -4165.344 | 0.911 | 0.357 | 0.207 | 88.90 | 0.125 | 04 | | |
| CECINT=DCC11 | WEAT NOW | NEXT | CALL DIS | PLAY | DISP | 1 05 | 1 | |
| | | 1 | | | | | | |

Figure 5-4 (Continued)

| | * | | | 4 5 4 0 S P I, A Y | | **** | |
|---|---|-------------------|-------------------|-----------------------|-----------------------|------------------|------|
| • | **** | ** ***** | . A + + + + 17: T | S P I. A Y | **** | *** 73.179.12.14 | • 28 |
| | ECC1 | c | COUNS ORSE | ∠VED CATA C | 1455 1 | | |
| | | - | J J | | | | |
| | TIMEI | nes. | VECT to | | CHINE | WFIGHT | |
| | | x | Y | z | 4√GL€ | # 1GIII | |
| | -4107.723 | 0.895 | 0.385 | 0.223 | 89-11 | 0.45% 03 | |
| | -4047.294 | 0.878 | 0.414 | 0.240 | 89.38 | 0.15# 03 | |
| | -4046.502 | 0.878 | 0.415 | 0.241 | 89.29 | 0.235 03 | |
| | ~3928.451 | 0.839 | 0.470 | 0.273 | 90.79 | 0.10F-07 | |
| | -3927.660 | 0.839 | 0 • 471 | 0.273 | 89.22 | 0.50F 02 | |
| | -3867.232 | 0.313 | 0.498 | 0.269 | 87.95 | 0.17E 03 | |
| | -3866.438 | 0.317 | 0.498 | 0.289 | 89.17 | | |
| | -3806.009 | 0.795 | 0.525 | 0.304 | 89,11 | 0.79F 02 | |
| | -3805.218 | 0.795 | 0.525 | - | | 0.10F-07 | |
| | -3748.388 | 0.772 | 0.550 | 0.304 | 88.10 | 0.26# 03 | |
| | -3747.557 | 0.772 | | 0.318 | 91.15 | 0.10F-07 | |
| | | | 0.550 | 0.319 | 92.46 | 0.495 02 | |
| | -3667-164 | 0.747 | 0.575 | 0.333 | 90.67 | 0.10F-07 | |
| | +3686.373 | 0.747 | 0.576 | 0.333 | 93.08 | 0.15F 03 | |
| | -3625.943 | 0.721 | 0.600 | 0.347 | 89.48 | 0.32F 02 | |
| | -3625.151 | 0.720 | 0.600 | 0.347 | 92.36 | 0 • 1 0F-07 | |
| | -3568.325 | 0.695 | 0.622 | 0.360 | 89+35 | 0.1007 | |
| | -3507.101 | 0.667 | 0.645 | 0.373 | 87.38 | 0+25F 02 | |
| | -3506.308 | 0•66 6 | 0.645 | 0.373 | 91.84 | 0.105-07 | |
| | -3445.877 | 0.637 | 0.667 | 0.386 | 89.71 | 0 • 105 - 07 | |
| | -3445.086 | 0.637 | 0.667 | 0.366 | 93.41 | 0.12F 03 | |
| | -3327.035 | 0.578 | 0.706 | 0.409 | 91.45 | 0.10E-07 | |
| | -3325.244 | 0.577 | 0.707 | 0.409 | 92.30 | 0.106-07 | |
| | -3265.812 | 0.546 | 0.725 | 0.420 | 94.56 | 0.33F 01 | |
| | -3265.021 | 0.545 | 0.726 | 0.420 | 91.12 | 0.10=-07 | |
| | 4592.234 | 0.948 | -0.277 | -0.157 | 85.21 | 0.63= 03 | |
| | 4593.020 | 0.948 | -0 - 277 | -0.157 | 84.82 | 0.19E 02 | |
| | 4653.457 | 0.959 | -0.246 | -0.139 | 85.52 | 0.596 03 | |
| | 4654.246 | 0.960 | -0.245 | -0.139 | 85.13 | 0.25E 02 | |
| | 4711.078 | 0.969 | -0.215 | -0.121 | 85.94 | 0.55 03 | |
| | 4711.863 | 0.969 | -0.215 | -0.121 | 87.72 | 0.24F 02 | |
| | 4772.297 | 0.978 | -0.183 | -0.102 | 85.93 | 0.615 03 | |
| | 4773.086 | 0.978 | -0.132 | -0.102 | 90.04 | 0.18F 02 | |
| | 4833.520 | 0.985 | -0.150 | -0.083 | 86.58 | | |
| | 4834.309 | 0.985 | -0.149 | -0.083 | | 0.46F 03 | |
| | 4891.141 | 0.991 | -0.119 | | 89.04 | 0.34 02 | |
| | 4891.930 | 0.991 | -0.119 | -0.065 | 86.44 | 0.60E 03 | |
| | 4952.363 | 0.995 | -0.118 -0.085 | -0.065 | 85.81 | 0.10F 03 | |
| | 4953-152 | 0.995 | | -0.046 | 86.80 | 0.57F 03 | |
| | 5013.586 | | -0.085 | -0.046 | 85.49 | 0.16F 03 | |
| | | 0.998 | -0.052 | -0.027 | 86.31 | 0.875 03 | |
| | 5014.371 | 0.998 | -0.051 | -0.027 | 89.29 | 0.64F 02 | |
| | 5071.207 | 1.000 | -0.050 | -0.009 | 86.61 | 0.84= 03 | |
| | 5071.996 | 1.000 | -0.020 | -0.008 | 86.29 | 0.24F 03 | |
| | 5132.426 | 1.000 | 0.013 | 0.011 | 87.57 | 0.62F 03 | |
| | 5133.219 | 1.000 | 0.014 | 0.011 | 87.03 | 0.265 03 | |
| | 5193+648 | 0.998 | 0.047 | 0.030 | 88.90 | 0.33F 03 | |
| | 5154.441 | 0.998 | 0.047 | 0.030 | 87.86 | 0.285 03 | |
| | CFC [NT=DCC11 | WHAT NOW | NEXT | CALL DIS | CI AV | 5105 1 05 1 | |
| | | eres and | ACA : | AWER DIZI | FLAT | DISP 1 OF 1 | |
| | | | | | and the second second | | |

Figure 5-4 (Continued)

C.

| ECC1 TIME1 | 0.956 0.996 0.991 0.986 0.986 0.986 0.967 0.976 0.983 0.990 0.994 0.998 1.000 0.999 0.993 0.993 0.993 0.991 0.926 0.911 | VECTOR Y 0.078 0.078 0.078 0.011 0.112 0.144 0.145 -0.265 -0.253 -0.221 -0.191 -0.158 -0.060 -0.027 0.038 0.103 0.169 0.326 0.385 0.416 | Z | CUNE ANGLE 87.26 86.99 87.69 88.11 87.69 85.49 86.48 88.16 86.29 87.18 86.37 87.19 85.75 87.19 85.75 87.31 87.54 88.13 86.83 86.81 86.81 | WEIGHT 0.115 04 0.57F 03 0.115 04 0.43F 03 0.17F 04 0.115 04 0.115 04 0.69F 02 0.31E 02 0.10F-07 0.35F 02 0.10F-07 0.35F 02 0.10F-07 0.56F 02 0.58F 02 0.10F-07 0.10F-07 0.10F-07 0.10F-07 0.10F-07 0.10F-07 0.10F-07 0.10F-07 0.10F-07 | |
|--|---|--|---|---|---|---|
| ### TINE1 ### \$251.270 ### \$252.063 ### \$312.492 ### \$374.574 ### \$ | RES. X 0.996 0.996 0.991 0.986 0.986 0.987 0.976 0.983 0.990 0.994 0.998 1.000 0.999 0.993 0.991 0.926 0.911 0.926 0.911 | VECTOR Y 0.078 0.078 0.111 0.112 0.144 0.145 -0.285 -0.253 -0.221 -0.191 -0.158 -0.060 -0.027 0.038 0.103 0.169 0.326 0.356 0.385 0.415 | 2 0.048 0.048 0.067 0.068 0.087 -0.164 -0.145 -0.127 -0.109 -0.050 -0.071 -0.053 -0.034 -0.014 0.023 0.061 0.099 0.189 0.207 0.223 | CUNE ANGLE 87.26 86.99 67.69 88.11 87.69 85.49 86.48 88.16 86.29 87.18 86.37 87.19 85.75 87.19 85.75 87.01 87.31 87.51 88.83 | 0.115 04 0.57F 03 0.115 04 0.435 03 0.17F 04 0.115 04 0.69F 02 0.31E 02 0.10F-07 0.35F 02 0.10F-07 0.35F 02 0.10F-07 0.56F 02 0.58F 02 0.10F-07 | |
| \$251.270 \$252.492 \$312.492 \$313.281 \$273.715 \$374.504 \$367.352 \$5188.508 \$5127.289 \$5188.508 \$5127.289 \$5066.064 \$506.445 \$4947.223 \$4866.000 \$4767.156 \$458.867 \$4226.961 \$4108.117 \$4268.117 \$4268.117 \$4268.056 \$308.056 | X 0.996 0.996 0.991 0.986 0.986 0.986 0.987 0.983 0.990 0.994 0.999 0.999 0.999 0.999 0.993 0.993 0.993 0.991 0.926 0.911 | Y 0.078 0.078 0.111 0.112 0.144 0.145 -0.285 -0.253 -0.221 -0.191 -0.158 -0.060 -0.067 0.038 0.103 0.169 0.326 0.356 0.356 0.355 0.415 | 0.048 0.048 0.067 0.087 0.087 -0.164 -0.127 -0.127 -0.050 -0.071 -0.053 -0.034 -0.014 0.023 0.061 0.099 0.189 0.207 | ANGLE 87.26 86.99 87.69 88.11 87.69 85.49 86.48 88.16 86.29 87.18 86.37 87.19 85.80 85.75 87.01 87.31 87.54 88.13 86.83 | 0.115 04 0.57F 03 0.115 04 0.435 03 0.17F 04 0.115 04 0.69F 02 0.31E 02 0.10F-07 0.35F 02 0.10F-07 0.35F 02 0.10F-07 0.56F 02 0.58F 02 0.10F-07 | |
| \$251.270 \$252.492 \$312.492 \$313.281 \$273.715 \$374.504 \$367.352 \$5188.508 \$5127.289 \$5188.508 \$5127.289 \$5066.064 \$506.445 \$4947.223 \$4866.000 \$4767.156 \$458.867 \$4226.961 \$4108.117 \$4268.117 \$4268.117 \$4268.056 \$308.056 | X 0.996 0.996 0.991 0.986 0.986 0.986 0.987 0.983 0.990 0.994 0.999 0.999 0.999 0.999 0.993 0.993 0.993 0.991 0.926 0.911 | Y 0.078 0.078 0.111 0.112 0.144 0.145 -0.285 -0.253 -0.221 -0.191 -0.158 -0.060 -0.067 0.038 0.103 0.169 0.326 0.356 0.356 0.355 0.415 | 0.048 0.048 0.067 0.087 0.087 -0.164 -0.127 -0.127 -0.050 -0.071 -0.053 -0.034 -0.014 0.023 0.061 0.099 0.189 0.207 | 87.26 86.99 87.69 88.11 87.81 97.69 85.49 86.48 88.16 86.29 87.18 86.37 87.19 85.80 85.75 87.01 87.31 87.31 87.53 | 0.57F 03 0.115 04 0.43F 03 0.17F 04 0.11° 04 0.69F 02 0.31E 02 0.10F-07 0.35F 02 0.10F-07 0.35F 02 0.10F-07 0.56F 02 0.58F 02 0.10F-07 | |
| \$252.063 \$312.492 \$313.281 \$273.715 \$374.504 \$368.574 \$367.352 \$5246.129 \$5188.508 \$5126.066 \$526.066 | 0.996 0.991 0.986 0.986 0.986 0.967 0.976 0.976 0.983 0.990 0.994 0.998 1.000 0.999 0.991 0.926 0.911 0.856 0.378 | 0.078 0.111 0.112 0.144 0.145 -0.265 -0.253 -0.221 -0.191 -0.158 -0.025 -0.094 -0.060 -0.027 0.038 0.103 0.169 0.326 0.356 0.385 0.415 | 0.048 0.067 0.068 0.087 0.087 -0.164 -0.127 -0.127 -0.050 -0.071 -0.053 -0.034 -0.014 0.023 0.061 0.099 0.189 0.207 | 86.99 88.11 87.81 87.69 85.49 86.48 88.16 86.29 87.18 86.37 87.19 85.80 85.75 87.01 87.31 87.31 88.13 86.83 | 0.57F 03 0.115 04 0.43F 03 0.17F 04 0.11° 04 0.69F 02 0.31E 02 0.10F-07 0.35F 02 0.10F-07 0.35F 02 0.10F-07 0.56F 02 0.58F 02 0.10F-07 | |
| # 312.492 # 313.281 # 273.715 # 374.504 # 5364.574 # 5367.352 # 5246.129 # 5188.508 # 5127.289 # 5008.445 # 4947.223 # 486.000 # 4767.316 # 468.316 # 425.867 # 426.961 # 4166.738 # 4108.117 # 4046.806 # 305.614 | 0.991 0.991 0.986 0.986 0.956 0.956 0.967 0.976 0.983 0.990 0.994 0.998 1.000 0.999 0.981 0.926 0.911 0.856 0.378 | 0.ff1 0.112 0.144 0.145 -0.285 -0.253 -0.221 -0.191 -0.125 -0.094 -0.060 -0.027 0.035 0.103 0.169 0.356 0.356 0.385 0.415 | 0.067 0.068 0.087 0.087 -0.164 -0.127 -0.127 -0.050 -0.071 -0.053 -0.034 -0.014 0.023 0.061 0.099 0.189 0.207 | 67.69 88.11 87.81 87.69 85.49 86.48 88.16 86.29 87.18 86.37 87.19 85.80 85.75 87.01 87.31 87.54 88.13 86.83 | 0.115 04 0.435 03 0.175 04 0.115 04 0.695 02 0.316 02 0.105-07 0.355 02 0.105-07 0.565 02 0.585 02 0.105-07 0.105-07 0.105-07 0.105-07 0.105-07 0.105-07 0.105-07 0.105-07 | |
| # # # # # # # # # # # # # # # # # # # | 0.991 0.986 0.986 0.944 0.956 0.967 0.976 0.983 0.990 0.994 0.998 1.000 0.999 0.993 0.981 0.926 0.911 0.856 0.378 | 0.112 0.144 0.145 -0.265 -0.253 -0.221 -0.191 -0.158 -0.125 -0.060 -0.087 0.038 0.103 0.169 0.326 0.356 0.385 0.415 | 0.068 0.087 0.087 -0.164 -0.145 -0.127 -0.109 -0.050 -0.071 -0.053 -0.034 -0.014 0.023 0.061 0.099 0.189 0.207 0.223 | 88.11 87.81 47.69 85.49 86.48 88.16 86.29 87.18 86.37 87.37 87.31 85.80 85.75 87.01 87.31 87.34 88.13 | 0.43E 03 0.17E 04 0.11E 04 0.69E 02 0.31E 02 0.10E-07 0.35E 02 0.10E-07 0.35E 02 0.10E-07 0.56E 02 0.58E 02 0.10E-07 0.10E-07 0.10E-07 0.10E-07 0.10E-07 0.10E-07 0.10E-07 | |
| £273.715 £374.504 £367.352 £367.352 £168.508 £127.289 £366.066 £508.445 £4947.223 £466.000 £4767.156 £468.316 £426.961 £4168.117 £4046.817 £4046.817 £368.056 | 0.986 0.986 0.944 0.956 0.957 0.976 0.983 0.999 0.999 0.999 0.999 0.993 0.981 0.926 0.911 | 0.144 0.145 -0.285 -0.253 -0.221 -0.191 -0.158 -0.125 -0.060 -0.060 -0.027 0.038 0.103 0.169 0.356 0.356 0.385 0.415 | 0.087 0.087 -0.164 -0.127 -0.127 -0.050 -0.071 -0.053 -0.014 -0.014 0.023 0.061 0.099 0.189 0.207 0.223 | 87.81 47.69 85.49 86.48 88.16 86.29 87.18 86.37 87.18 86.37 87.18 85.75 87.01 87.31 87.31 87.31 88.13 86.83 86.83 | 0.17F 04 0.11° 04 0.69F 02 0.31E 02 0.10F-07 0.38F 02 0.10F-07 0.35E 02 0.10F-07 0.56F 02 0.58F 02 0.10F-07 0.10F-07 0.10F-07 0.10F-07 0.10F-07 0.10F-07 0.10F-07 | |
| 5374.504 -5368.574 -5368.574 -5367.352 -5188.508 -5188.508 -508.445 -4947.223 -4866.066 -5008.445 -4947.223 -4868.316 -4525.867 -4226.961 -4165.738 -4108.817 -408.8187 -4 | 0.986 0.944 0.956 0.967 0.976 0.983 0.990 0.994 0.998 1.000 0.999 0.993 0.981 0.926 0.911 | 0.145 -0.285 -0.253 -0.221 -0.191 -0.158 -0.125 -0.060 -0.027 0.038 0.103 0.169 0.326 0.356 0.385 0.415 | 0.087 -0.164 -0.145 -0.127 -0.127 -0.050 -0.071 -0.053 -0.034 -0.014 0.023 0.061 0.099 0.189 0.207 | 87.69 85.49 86.48 88.16 86.29 87.18 86.37 87.19 85.80 85.75 87.01 87.31 87.31 88.13 86.83 | 0.11% 04 0.69% 02 0.31% 02 0.10%-07 0.38% 02 0.10%-07 0.35% 02 0.10%-07 0.56% 02 0.58% 02 0.10%-07 0.10%-07 0.10%-07 0.10%-07 0.10%-07 0.10%-07 | |
| -5368.574 -5367.352 -5246.129 -5188.508 -5127.289 -5127.289 -5026.066 -5008.445 -4947.223 -4866.000 -4767.156 -4648.316 -4525.867 -4226.961 -4165.738 -4168.17 -4046.898 -3528.056 | 0.944 0.956 0.967 0.976 0.983 0.990 0.994 0.998 1.000 0.999 0.963 0.981 0.926 0.911 0.856 0.878 | -0.285 -0.253 -0.221 -0.191 -0.158 -0.125 -0.060 -0.027 0.038 0.103 0.169 0.326 0.356 0.385 0.415 | -0.164 -0.145 -0.127 -0.127 -0.109 -0.050 -0.071 -0.053 -0.034 -0.014 0.023 0.061 0.099 0.189 0.207 | 85.49 86.48 88.16 86.29 87.18 86.37 87.19 85.80 85.75 87.01 87.31 87.54 88.13 86.83 | 0.69F 02 0.31E 02 0.10F-07 0.38F 02 0.10F-07 0.35E 02 0.10E-07 0.56E 02 0.58F 02 0.10E-07 0.10E-07 0.10F-07 0.10F-07 0.10F-07 0.17F 02 0.30F 02 | |
| -53C7.352 -5246.129 -5188.508 -5127.289 -5008.445 -4947.223 -4866.000 -4767.316 -464.316 -425.867 -426.961 -4165.738 -4108.198 -4406.898 -3528.056 -3805.614 | 0.956 0.967 0.976 0.983 0.990 0.994 0.998 1.000 0.999 0.963 0.981 0.926 0.911 0.896 0.878 | -0.253 -0.221 -0.191 -0.158 -0.125 -0.094 -0.060 -0.027 0.035 0.103 0.169 0.326 0.356 0.385 0.415 | -0.145 -0.127 -0.109 -0.050 -0.071 -0.053 -0.034 -0.014 0.023 0.061 0.099 0.189 0.207 | 86.46 88.16 86.29 87.18 86.37 87.19 85.80 85.75 87.01 87.31 87.54 88.13 86.83 | 0.318 02 0.10F-07 0.38F 02 0.10F-07 0.35F 02 0.10E-07 0.56F 02 0.58F 02 0.10E-07 0.10F-07 0.10F-07 0.10F-07 0.10F-07 0.10F-07 | |
| -5246.129 -5168.508 -5127.286 -5127.286 -5008.445 -4947.223 -466.000 -4767.156 -4648.316 -4525.667 -4226.961 -4165.738 -4108.117 -4046.85 -3628.056 | 0.967 0.976 0.983 0.990 0.994 0.998 1.000 0.999 0.963 0.981 0.926 0.911 0.878 | -0.221 -0.191 -0.158 -0.125 -0.094 -0.060 -0.027 0.038 0.103 0.169 0.326 0.356 0.385 0.415 | -0.127 -0.109 -0.050 -0.071 -0.053 -0.034 -0.014 -0.023 0.061 0.099 0.189 0.207 | 88.16 86.29 87.18 86.37 87.19 85.80 85.75 87.01 87.31 87.54 88.13 86.83 | 0.10F-07 0.38F 02 0.10F-07 0.35F 02 0.10F-07 0.56F 02 0.58F 02 0.10F-07 0.10F-07 0.10F-07 0.10F-07 0.10F-07 0.10F-07 | |
| -5188.508 -5127.289 -5066.066 -5008.445 -4947.223 -4666.000 -4767.156 -4648.316 -4525.667 -4226.961 -4165.738 -4108.117 -4408.898 -3928.056 -3805.614 | 0.976 0.983 0.990 0.994 0.998 1.000 0.999 0.993 0.981 0.926 0.911 0.856 0.878 | -0.191 -0.158 -0.125 -0.094 -0.060 -0.027 0.038 0.103 0.169 0.326 0.356 0.385 0.415 | -0.109 -0.050 -0.071 -0.053 -0.034 -0.014 .0.023 0.061 0.099 0.189 0.207 | 86.29 87.18 86.37 87.19 85.80 85.75 87.01 87.31 87.54 88.13 86.83 | 0.38F 02 0.10F-07 0.35E 02 0.10E-07 0.56E 02 0.58F 02 0.10E-07 0.10E-07 0.10F-07 0.10F-07 0.10F-07 0.10F-07 | |
| -5127.289 -5066.066 -5008.445 -4947.223 -4866.000 +4767.156 -4648.316 -4525.867 -4226.961 -4165.738 -4108.117 -4046.898 -3528.056 | 0.983 0.990 0.994 0.998 1.000 0.999 0.963 0.981 0.926 0.911 0.856 0.878 | -0.158 -0.125 -0.094 -0.060 -0.027 0.038 0.103 0.169 0.326 0.356 0.385 0.415 | -0.050 -0.071 -0.053 -0.034 -0.014 0.023 0.061 0.099 0.189 0.207 0.223 | 87.18 86.37 87.19 85.80 85.75 87.01 87.31 87.54 88.13 86.83 | 0.10=-07 0.35E 02 0.10E-07 0.56E 02 0.58F 02 0.10E-07 0.10E-07 0.10E-07 0.10E-07 0.17F 02 0.30E 02 | |
| -5066.066 -5008.445 -4947.223 -4866.000 -4767.156 -4648.316 -4525.867 -4226.961 -4165.738 -4168.47 -4046.898 -3528.056 | 0.990 0.994 0.998 1.000 0.999 0.963 0.981 0.926 0.911 0.856 0.378 | -0.125 -0.094 -0.060 -0.027 0.038 0.103 0.169 0.326 0.356 0.385 0.415 | -0.071 -0.053 -0.034 -0.014 -0.023 0.061 0.099 0.189 0.207 0.223 | 86.37 87.19 85.80 85.75 87.01 87.31 87.54 88.13 86.83 | 0.35% 02 0.10%-07 0.56% 02 0.58% 02 0.10%-07 0.10%-07 0.10%-07 0.10%-07 0.17% 02 0.30% 02 | |
| -5008.445 -4947.223 -4866.000 -4767.156 -4648.316 -4525.867 -4226.961 -4165.738 -4168.117 -4046.817 -3528.056 | 0.994 0.998 1.000 0.999 0.963 0.981 0.926 0.911 0.896 0.378 | -0.094 -0.060 -0.027 0.039 0.103 0.169 0.326 0.356 0.385 0.415 | -0.053 -0.034 -0.014 -0.023 0.061 0.099 0.189 0.207 0.223 | 87.19 85.80 85.75 87.01 87.31 87.54 88.13 86.83 | 0.105-07 0.56E 02 0.58F 02 0.105-07 0.105-07 0.105-07 0.105-07 0.17F 02 0.30F 02 | |
| -4947.223 -4866.000 +4767.156 -4648.316 -4525.867 -4226.961 -4165.738 -4108.117 -4046.898 -3528.056 | 0.998 1.000 0.999 0.993 0.981 0.926 0.911 0.896 0.378 | -0.060 -0.027 0.038 0.103 0.169 0.326 0.356 0.385 0.415 | -0.034 -0.014 -0.023 -0.061 -0.099 -0.189 -0.207 -0.223 | 85.80 85.75 87.01 87.31 87.54 88.13 86.83 | 0.56E 02 0.58F 02 0.10E-07 0.10E-07 0.10E-07 0.10F-07 0.17F 02 0.30F 02 | |
| -4866.000 +4767.156 -4648.316 -4825.867 -4226.961 -4168.117 -4046.898 -3928.056 | 1.000 0.999 0.963 0.981 0.926 0.311 0.896 0.378 | -0.027 0.038 0.103 0.169 0.326 0.356 0.385 | -0.014 -0.023 -0.061 -0.099 -0.189 -0.207 -0.223 | 85.75 87.01 87.31 87.54 88.13 86.83 | 0.58F 02 0.105-07 0.105-07 0.105-07 0.105-07 0.17F 02 0.30F 02 | |
| +4767.156 -4648.316 -4525.867 -4526.961 -4168.117 -4046.898 -3528.056 -3805.614 | 0.999 0.993 0.981 0.926 0.911 0.896 0.378 | 0.038 0.103 0.169 0.326 0.356 0.385 | 0.023 0.061 0.099 0.189 0.207 0.223 | 87.01 87.31 87.54 88.13 86.83 86.51 | 0.105-07 0.105-07 0.105-07 0.105-07 0.175-02 0.305-02 | |
| -4648.316 -4525.867 -4226.961 -4165.738 -4168.478 -4046.898 -3528.056 | 0.993 0.981 0.926 0.911 0.896 0.378 | 0.103 0.169 0.326 0.356 0.365 0.415 | 0.061 0.099 0.189 0.207 0.223 | 87.31 87.54 88.13 86.83 86.51 | 0.10%-07 0.10%-07 0.10%-07 0.17%-02 0.30%-02 | |
| -4525.867 -4226.961 -4165.738 -4108.117 -4046.898 -3528.056 -3805.614 | 0.981 0.926 0.911 0.896 0.878 | 0.169 0.326 0.356 0.385 0.415 | 0.099 0.189 0.207 0.223 | 87.54 88.13 86.83 86.51 | 0.10F-07 0.10F-07 0.17F 02 0.30F 02 | |
| -4226.961 -4165.738 -4108.117 -4046.898 -3928.056 -3805.614 | 0.926 0.911 0.896 0.878 | 0.326 0.356 0.385 0.415 | 0.189 0.207 0.223 | 88 • 1 3 86 • 8 3 86 • 5 1 | 0.10F-07 0.17F 02 0.30F 02 | |
| -4165.738 -4168.117 -4046.898 -3928.056 -3805.614 | 0.911 0.896 0.878 | 0.356 0.385 0.415 | 0.207 0.223 | 86.83 86.51 | 0.17F 02 0.30F 02 | |
| -4168.117 -4045.898 -3928.056 -3805.614 | 0.396 0.378 | 0.385 0.415 | 0.223 | 86.51 | S0 30E 0 | |
| -4045.898 -3928.056 -3805.614 | 0.878 | 0.415 | | | | |
| -3928.056 -3805.614 | | | 0.240 | | | |
| -3805.614 | 0.839 | 0.470 | | | 0.10=-07 | |
| | | | 0.273 | 92.32 | 0.10F-07 | |
| | 0.795 | 0.525 | 0.304 | 92.79 | 0.10=-07 | |
| -3747.992 | 0.772 | 0.550 | 0.319 | 92.43 | 0.10F-07 | |
| -3686.769 | 0.747 | 0.575 | 0.333 | 92.95 | 0.10=-07 | |
| -3445.482 | 0.637 | 0, 667 | 0.386 | 92.72 | 0.105-07 | |
| -3367.860 | 0.609 | 0 - 687 | 0.357 | 91.85 | 0.105-07 | • |
| -3326.640 | 0.578 | 0.707 | 0.409 | 92.12 | 0.105-07 | |
| -3265.416 | 0.546 | 0.725 | 0.420 | 92.20 | 0.105-07 | |
| 4592.629 | 0.548 | -0.277 | -0.157 | 85.29 | 0.78F 02 | |
| 4653.852 | 0,959 | -0.245 | -0.139 | 65.62 | 0.64F 02 | |
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| 00,74,607 | J 4 7010 | 0 2 5 - 0 | 0.00. | Ç . ₹ ₹ ₹ | J. J. | |
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| | | | | i i | | |
| ECUNT-BOCIT | WHAT NOW | | CALL DIS | FLAY | 01SP 1 NF 1 | |
| and the second of the second o | | | 97,255 913 | ***** | 2 101 4 | |
| | 4711.473 4772.691 4833.914 4891.635 4962.758 5013.980 6071.602 6132.824 6251.664 5312.887 6374.109 | 4772.691 0.978 4833.914 0.985 4891.835 0.991 4952.758 0.995 5013.980 0.993 5071.602 1.000 6132.824 1.000 6251.664 0.996 5312.887 0.991 6374.109 0.986 | 4772.691 0.978 -0.182 4833.914 0.985 -0.149 4891.835 0.991 -0.118 4952.758 0.995 -0.085 5013.980 0.993 -0.052 6071.602 1.000 -0.020 6132.824 1.000 0.013 6251.664 0.996 0.078 5312.887 0.991 0.112 6374.109 0.986 0.145 | 4772.691 0.978 -0.182 -0.102 4833.914 0.985 -0.149 -0.083 4891.835 0.991 -0.118 -0.065 4952.758 0.995 -0.085 -0.046 5013.980 0.993 -0.052 -0.027 9071.602 1.000 -0.020 -0.009 6132.824 1.000 0.013 0.011 6251.664 0.996 0.078 0.048 5312.887 0.991 0.112 0.068 5374.109 0.986 0.145 0.087 | 4772.691 0.978 -0.182 -0.102 84.87 4833.914 0.985 -0.149 -0.083 86.01 4891.835 0.991 -0.118 -0.065 86.84 4952.758 0.995 -0.085 -0.046 88.11 5013.980 0.993 -0.052 -0.027 84.74 5071.602 1.000 -0.020 -0.009 86.95 6132.824 1.000 0.013 0.011 88.51 6251.664 0.996 0.078 0.048 87.87 5312.887 0.991 0.112 0.068 86.91 6374.109 0.986 0.145 0.087 88.31 | 4772.691 0.978 -0.182 -0.102 84.97 0.97F 02 4833.914 0.985 -0.149 -0.083 86.01 0.48F 02 4891.835 0.991 -0.118 -0.065 86.84 0.17F 02 4952.758 0.995 -0.085 -0.046 88.11 0.10F-07 5013.980 0.993 -0.052 -0.027 84.74 0.10F 03 5071.602 1.000 -0.020 -0.009 86.95 0.10F-07 6132.824 1.000 0.013 0.011 88.51 0.10F-07 6251.664 0.996 0.078 0.048 87.87 0.10F-07 5312.887 0.991 0.112 0.068 86.91 0.13F 02 6374.109 0.946 0.145 0.067 88.31 0.10F-07 |

Figure 5-4 (Continued)

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                                       M S A D
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                                     DISPLAY
                                                     ********** 73.179.12.14.40 ****
                                                                                    **
$ 0
         CCC2
                             CCCONS GBSERVED DATA CLASS 2
                                                                                    **
**
**
       TIMES
                 REF.
                        VECTOR ONE
                                      REF.
                                             VECTOD TWO
                                                           DIHED
                                                                   WEIGHT
**
                                                           ANGLE
                                                                                    **
**
        -5368.569 -0.947 +0.296 +0.128 0.944 +0.286 -0.164
                                                           142.33 0.305 05
                                                                                    **
       -5368-180 -0.947 -0.296 -0.128 0.944 -0.285 -0.164
** -
                                                            142-11
                                                                   0.13E 04
                                                                                    * *
**
       -5307.746 -0.947 -0.296 -0.128
                                       0.956 -0.254 -0.146
                                                           144.€3
                                                                   0.285 05
*
       -5306.957 -0.947 -0.296 -0.128
                                      0.956 -0.253 -0.145
                                                            145.13
                                                                   0.65# 03
                                                                                    **
44
       -$246.523 -0.947 -0.296 -0.128
                                       0.967 -0.221 -0.127
                                                                   0.26F 05
                                                            146 - 81
                                                                                    **
**
       - 5245.734 -0.547 -0.296 -0.128
                                       0.967 -0.221 -0.127
                                                           147.68
                                                                   E0 R88.0
                                                                                    **
**
       -5186.902 -0.947 -0.296 -0.128
                                       0.976 -0.191 -0.109
                                                            148.83
                                                                    0.25E 05
                                                                                    * *
*
       -5188.113 -0.947 -0.296 -0.128
                                      0.976 -0.190 -0.109
                                                           148.79
                                                                   0.195 04
                                                                                    **
**
       -5127.684 -0.947 -0.296 -0.128
                                       0.983 -0.158 -0.090
                                                            150.91
                                                                   0.215 05
                                                                                    **
**
       -5126.891 -0.947 -0.296 -0.128
                                       0.983 -0.158 -0.090
                                                            150.ai
                                                                    0.43E 04
                                                                                    **
**
       -5066.461 -0.947 -0.296 -0.128
                                       0.990 -0.125 -0.071
                                                            153.48
                                                                   0.225 05
*
       -5065.668 -0.947 -0.296 -0.128
                                      0.990 -0.125 -0.071
                                                            153.81
                                                                   0.23F 04
                                                                                    **
**
       -5008.640 -0.947 -0.296 -0.128 0.994 -0.094 -0.053
                                                                   0.215 05
                                                           155.47
                                                                                    **
**
       -5008.047 -0.947 -0.296 -0.128 0.994 -0.093 -0.053 155.76
                                                                   0.295 04
                                                                   0.19F 05
**
       -4947.617 -0.947 -0.296 -0.128
                                      0.998 -0.060 -0.034
                                                            157.70
                                                                                    **
       -4346.828 -0.947 -0.296 -0.128
* *
                                      U.998 -0.060 -0.034
                                                                   0.425 04
                                                           157.55
                                                                                    **
**
       -4886.395 -0.947 -0.296 -0.128
                                      1.000 -0.027 -0.015
                                                           159.83
                                                                   0.18F 05
                                                                                    **
       -4885.605 -0.947 -0.296 -0.128
**
                                      1.000 -0.025 -0.014
                                                            159.58
                                                                   0.54F 04
                                                                                    **
44
       -4826.777 -0.947 -0.296 -0.128
                                      1.000
                                                                   0.17= 05
                                              0.005 0.004
                                                           161.74
**
       -4827.980 -0.947 -0.296 -0.128
                                       1.000
                                              0.005
                                                            162.33
                                                                   0.44E 04
                                                    0.004
                                                                                    **
       -4767.551 -0.947 -0.256 -0.128
                                      0.999
                                              0.033 0.023
                                                           164.21
                                                                   0.16F 05
                                                                                    **
**
       -4766.762 -0.947 -0.296 -0.128
                                      0.999
                                              0.039
                                                   0.023
                                                           164.23
                                                                   0.555 04
                                                                                    **
**
       -4706.328 -0.947 -0.296 -0.128
                                      0.997
                                              0.072
                                                    0.042
                                                            166.31
                                                                   0.15E 05
                                                                                    **
**
       -4706.535 -0.947 -0.296 -0.129
                                      0.996
                                              0.072
                                                                   0.595 04
                                                   0.043
                                                           166 - 65
                                                                                    **
**
       -4646.711 -0.947 -0.296 -0.128
                                      0.993
                                              0.103
                                                           168.34
                                                                   0.14E 05
                                                    0.060
                                                                                    **
       -4647.918 -0.947, -0.296 -0.128
                                      0.993
                                              0.103 0.061
                                                           168.31
                                                                   0.67E 04
                                                                                    **
**
       -4587.488 -0.947 -0.296 -0.128
                                      U.987
                                                                   0.135 05
                                              0.136
                                                     0.080 170.61
**
       -4586.695 -0.947 -0.296 -0.128
                                      0.987
                                              0.136
                                                     0.080
                                                           170.94
                                                                   0.748 04
                                                                                    **
       -4526.266 -0.947 -0.296 -0.128
                                      0.981
                                                    0-099
                                                           172.48
                                                                   0.125 05
                                              0.169
                                                                                    **
*
       -4525.473 -0.947 -0.296 -0.128
                                      0.981
                                              0.169
                                                     0.099
                                                           173.00
                                                                   0.79F 04
                                                                                    **
       -4468.645 +0.947 -0.296 -0.128
**
                                                           174.92
                                       0.973
                                                                   0.125 05
                                              0.200
                                                     0.116
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**
       -4467.852 -0.947 -0.296 -0.128
                                      G 4973
                                              0.200
                                                           175.16
                                                                   0.85E 04
                                                    0.117
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**
        -4407.422 -0.947 -0.296 -0.128
                                      0.963
                                              0.232
                                                    0 . 1 35
                                                           177.14
                                                                   0.11F 05
                                                                                    **
       -4406.629 -0.947 -0.296 -0.128
                                      0.963
                                              0.233
                                                     0.135
                                                           177.32
                                                                   0.93E 04
                                                                                    **
**
       -4346.203 -0.947 -0.296 -0.128
                                       0.952
                                                           179.27
                                              0.264
                                                     0.154
                                                                   0.105 05
**
       -4345.410 -0.947 -0.296 -0.128
                                      0.952
                                              0.265
                                                           179.44
                                                                   0.99E 04
                                                    0.154
                                                                                    **
**
       -4288.582 -0.947 -0.296 -0.128
                                      0.940
                                              0.294
                                                    0.171
                                                           181.37
                                                                   0.97F 04
                                                                                    **
**
       -4287.785 -0.947 -0.296 -0.128
                                      0.940
                                              0.295
                                                     0.171
                                                           181.65
                                                                   0.10E 05
       -4227.355 -0.947 -0.296 -0.128
**
                                      0.926
                                                     0.189
                                              0.325
                                                           183.84
                                                                   0.10E 05
.
       -4226.566 -0.947 -0.296 -0.128
                                      0.926
                                                    0.189
                                              0.326
                                                           183.80
                                                                   0.10E 05
                                                                                    **
**
       -4166.137 -0.947 -0.296 -0.128
                                      0.911
                                              0.356
                                                           185.85
                                                                   0.96E 04
                                                     0.207
                                                                                    **
       -4165.344 -0.947 -0.296 -0.128
                                      0.911
                                              0.357
                                                           185.68
                                                                   0.11E 05
                                                                                    * *
                                                     0.207
**
       -4107.723 -0.947 -0.296 -0.128
                                      0.895
                                              0.385
                                                     0.223
                                                           187.82
                                                                   0.11F 05
**
       -4047.294 -0.947 -0.296 -0.128
                                      0.878
                                              0.414
                                                     0.240
                                                           190.02
                                                                   0.93E 04
                                                                                    **
**
       -4046.502 -0.947 -0.296 -0.128
                                      0.378
                                              0.415
                                                     0.241
                                                           190.03
                                                                   0.11E 05
                                                                                    **
**
       -3928.451 -0.947 -0.296 -0.128
                                      0.839
                                              0.470
                                                     0.273
                                                          194.39
                                                                                    **
                                                                   0.105-07
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**
       CECINT=DCC22 WHAT NOW
                                           CALL DISPLAY
                                                              DISE
                                                                     1 OF
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                                       MSAD
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**********
                                     DISPLAY
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Figure 5-5

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M S.A O
                                      -- BISPLAY
                                                        ############# -73.170.12.14.43
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**
          ECC2
                               DCCONS OBSERVED DATA GLASS 2----
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**
        TIME 2
                  PEF.
                          VECTOR DINE
                                        REF
                                                VECTOR TWO
                                                              DIMED
                                                                       METCHT
**
                                                               ANGLE
        -3927.660 -0.947 -0.296 -0.128
                                         0.839
                                                 0.471
                                                        0.273
                                                               194.32
                                                                        0.10E 05
**
        -3867.232 -0.947 -0.296 -0.128
                                         0.818
                                                 0.498
                                                        0.289
                                                               196.28
                                                                        0-62F 04
**
        -3866.438 -0.947 -0.296 -0.128
                                         0.817
                                                 0.498
                                                        0.289 196.50
                                                                        0.115 05
        -3806.009 -0.947 -0.296 -0.128
                                         0.795
                                                 0.525
                                                        0.304
                                                               198.70
                                                                        0.108-07
        -3805.218 -0.947 -0.256 -0.128
                                         0.795 - 0-525
                                                        0.304
                                                               198.61
                                                                        0-16E-05
$ ±
        -3746.388 -0.947 -0.256 -0.128
                                         0.772
                                                 0.550
                                                                        0.10F-07
                                                        815.0
                                                               200.86
                                                                                          --
        -3747.597 -0.947 -0.296 -0.128
                                         0.772
                                               0.550 0.319
                                                               200-84 - 0-44E-05
                                                                                          --
        -3687.164 -0.947 -0.296 -0.128
                                         0.747
                                                 0.575
                                                        0.333
                                                               203 - 06
                                                                        0.105-07
4#
        -3686.373.+0.947:-0.296 -0.128
                                         0.747
                                                 0.576
                                                        0.333 203.01 0.355 05
                                                                                         --**
        -3625.943 -0.947 -0.296 -0.128
**
                                         0.721
                                                0.600
                                                        0.347 205.12
                                                                       0.655 04
                                                                                          **
--
        -3625.151 -0.947 -0.296 -0.128
                                         0.720 - 0.600 - 0.347 - 205.27 - 0.10F-07
        -3568.325 -0.947 -0.296 -0.128
                                                0.622
                                         0.695
                                                        0.360
                                                               207-29
                                                                        0.105-07
**
        -3507.101 -0.947 -0.296 -0.128
                                         0.667---0.645---0.373---209.34 -- 0.35F-04--
                                                                                         **
        -3506.308 -0.947 -0.296 -0.128
44
                                         0.666
                                                 0.645
                                                        0.373
                                                               209.57
                                                                        0.105-07
        -3445.677 -0.947 -0.296 -0.128
                                         0.637
                                                 0.667
                                                        0.386
                                                               211.73
                                                                        0.10E-07
                                                                                         **
       -3445.086 -0.947 -0.296 -0.128
                                         0.637
                                                 0.667
                                                        0.386
                                                               211.73 -0.525 05
                                                                                          **
4 ....
        -3327-035--0-947--0-296 -0-128
                                         0.578-0.706 0.409 216.05 0.105-07-
        -3326.244 -0.947 -0.296 -0.128
                                         0.577
                                                0.707 0.409
                                                               216.07
                                                                        0.10F-07
                                                                                         **
**
        -3265.812 -0.947 -0.296 -0.128
                                         0.546 0.725 0.420 ....
                                                               218-13-
                                                                       0.175 03
                                                                                          * *
**
        -3265.021 -0.947 -0.296 -0.128
                                         0.545
                                                0.726 0.420
                                                               218-29
                                                                        0.108-07
                                                                                         **
         4592-234 -0.946 -0.297 -0.129
**
                                         0.948 -0.277 -0.157
                                                               142.97
                                                                       0.29F 05
                                                                                         4 4
**
         4593.020 -0.946 -0.297 -0.129
                                         0.948 -0.277 -0.157
                                                               143.06
                                                                       0.61F 03
         4653-457 -0.946 -0.297 -0.129
                                         0.959 -0.246 -0.139
                                                               145-14--0-28E-05
**
         4654.246 -0.946 -0.297 -0.129
                                         0.960 -0.245 -0.139
                                                               145-22 0-82F 03
         4711.078 -0.946 -0.297 -0.129
44
                                         0.969 -0.215 -0.121
                                                               147 - 19 -- 0 - 26F 05-
         4711.663 -0.946 -0.297 -0.129
                                                                       0.17E 04
                                         0.969 -0.215 -0.121
                                                               147.01
         4772.297 -0.946 -0.297 -0.129
                                         0.978 -0.183 -0.102
                                                               140-44.
                                                                       0.24E 05
                                                                                         **
4 *
         4773.086 -0.946 -0.297 -0.129
                                         0.978 -0.182 -0.102
                                                               140.00
                                                                       0.41F 04
                                                                                         44
         4833.520--0.946 -0.297 -0.129
                                         0.985--0.150--0.083--151-54--0.22E.05-
         4834.309 -0.946 -0.297 -0.129
                                         0.985 -0.149 -0.083
                                                               151.35
                                                                       0.36% 04
         4891-141 -0-946 -0-297 -0-129
**
                                         0.991 -- 0.119 -0.065
                                                               153.69 0.22E 05
                                                                                         **
**
         4891.930 -0.946 -0.297 -0.129
                                         0.991 -0.118 -0.065
                                                               153.83
                                                                      0.265 04
                                                                                         ..
         4952.363 -0.946 -0.297 -0.129
**
                                         0.995 -0.085 -0.046
                                                               155.87
                                                                       0.20E 05
         4953.152 -0.946 -0.297 -0.129
                                         0.995 -0.085 -0.046
                                                               156.15
                                                                       0.305 04
                                                                                         **
**
         5013-586 -0-946--0-297--0-129
                                         0.998 -0.052 -0.027 - 158.25 - 0.195 05
                                                                                         * *
         5014.371 -0.946 -0.297 -0.129
**
                                         0.998 -0.051 -0.027
                                                               157.84
                                                                       0.55E 04
                                                                                         * *
         5071.207 -0.946 -0.297 -0.129
                                         1.000 -0.020 -0.009
                                                                       0.185 05
                                                               160.28
                                                                                         **
**
         5071-996 -0.946 -0.297 -0.129
                                         1.000 -0.020 -0.008
                                                               160.37
                                                                       0.425 04
                                                                                         **
**
         E132.426 -0.946 -0.297 -0.129
                                         1.000
                                                0.013
                                                       0.011
                                                                       0.16度.05
                                                               162.33
                                                                                         **
         £133.219 -0.946 -0.297 -0.129
                                         1.000
                                                0.014
                                                       0.011
                                                               162.46
                                                                       0.50€ 04
         $193.648 -0.946 -0.297 -0.129
                                         0.998
                                                0.047 0.030
                                                               164.35 0.14E 05
                                                                                         **
         E194.441 -0.946 -0.297 -0.129
**
                                         0.998
                                                0 - 047
                                                        0.030
                                                               164.56
                                                                       0.59E 04
24
         £251.270 -0.946 -0.297 -0.129
                                         0.996
                                                0.078
                                                               166.78
                                                      . 0.048
                                                                      -0.15E 05
                                                                                         **
         5252.063 -0.946 -0.297 -0.129
                                         0.996
                                                0.078
                                                        0.048
                                                               166.89
                                                                       0.62E 04
         E312.492 -0.946 -0.297 -0.129
                                         0.991
                                                0.111
                                                        0.067
                                                               168.87
                                                                       0.145 05
         E313.281 -0.946 -0.297 -0.129
**
                                         0.991
                                                0.112
                                                       0.068
                                                               168.79
                                                                       0.68E 04
                      WHAT NOW
                                  NEXT
                                             CALL DISPLAY
                                                                  DISP
                                                                         1 NF
                                                                                         **
              ********
                                          M S A D
                                      DISPLAY
```

Figure 5-5 (Continued)

```
4 S 4 D
                                                     ** *** *** *** *** *** *** *** *** **
                                     D I S P L A Y . ******** 73.179.12.14.46
**
                                                                                    **
                             DOCCHS OBSERVED CATA CLASS 2
**
        ECC2
                                                                                    **
                                                                                    **
                                                           DIHED
                                                                   WFIGHT
                 REF.
                        VECTOR LINE
                                      REF .
                                             VECTOR TWO
       TIME2
**
                                                                                    **
                                                           ANGLE
*
        5373.715 -0.946 -0.297 -0.129 0.986 0.144
                                                     0.087
                                                           171.20
                                                                   0.136 05
                                                                                    **
                                      0.986 0.145 0.087
                                                                    0.76E 04
                                                                                    **
        5374.504 -0.946 -0.297 -0.129
                                                           171.28
**
                                                                    0.105 05
                                                                                    **
                                       0.944 -0.285 -0.164
                                                            142.30
        -5368.574 -0.947 -0.296 -0.128
**
       -5307.352 -0.947 -0.296 -0.128
                                       0.956 -0.253 -0.145
                                                            144.71
                                                                    0.10E 05
**
       -5246.129 -0.947 -0.296 -0.128
                                      0.967 -0.221 -0.127
                                                           146.96
                                                                    0.10E 05
                                                                                    44
**
                                       0.976 -0.191 -0.109
                                                            148.83
                                                                    0.10E 05
                                                                                    * *
        -$186.508 -0.947 -0.296 -0.128
**
                                       0.983 -0.158 -0.090
                                                                    0.10E 05
                                                           150.88
       -5127.289 -0.947 -0.296 -0.128
**
                                                                                    **
                                                           153.57
                                                                    0.10E 05
                                       0.990 -0.125 -0.071
       -5066.066 -0.947 -0.296 -0.129
**
                                                            155.56
                                                                    0.10E 05
                                                                                    **
       -5008.445 -0.947 -0.296 -0.128
                                       0.994 -0.094 -0.053
**
        -4947.223 -0.947 -0.296 -0.128
                                      0.998 -0.060 -0.034
                                                           157.66
                                                                    0.10E 05
                                                                                    **
**
                                                            159.75
                                                                    0.10E 05
                                                                                    **
        -4886.000 -0.947 -0.296 -0.128
                                      1.000 -0.027 -0.014
4*
                                                                    0.10F 05
                                                                                    **
                                              0.038
                                                    0.023
                                                            154.22
       -4767.156 -0.947 -0.296 -0.128
                                       0.999
**
                                                            168.33
                                                                    0.10E 05
                                                                                    **
       -4648.316 -0.947 -0.296 -0.128
                                      0.993
                                              0.103
                                                    0.061
**
                                                    0.099
                                                            172.99
                                                                    0.10E 05
                                                                                    **
                                       0.981
                                              0.169
       -4525.867 -0.947 -0.296 -0.128
                                                                    0.10E 05
       -4226.961 -0.947 -0.296 -0.128
                                                            183.82
                                       0.926
                                              0.326
                                                    0.189
$*
                                                                    0.105 05
                                                                                     * *
                                                    0.207
                                                            185.76
       -4165.738 -0.947 -0.296 -0.128
                                       0.911
                                              0.356
**
                                                            187.93
                                                                    0.10E 05
                                                                                    **
       -410E.117 -0.947 -0.296 -0.128
                                              0.385
                                                    0.223
                                       0.896
**
                                                                                     **
                                                            190.02
                                                                    0.105 05
       -4046.898 -0.947 -0.296 -0.128
**
                                       0.878
                                              0.415
                                                    0.240
                                                                    0.10E 05
                                                            194.35
        -3928.056 -0.947 -0.296 -0.128
                                       0.839
                                              0.470
                                                    0.273
**
                                                                    0.10E 05
                                                                                     **
                                                    0.304
                                                            198+64
       -3805.614 -0.947 -0.296 -0.128
                                       0.795
                                              0.525
*
                                                   0.319
                                                            200.82
                                                                    0.105 05
                                                                                     **
       -2747.992 -0.947 -0.296 -0.128
                                      0.772
                                              0.550
44
                                                                                     **
                                                            202.98
                                                                    0.105 05
       -3686.769 -0.947 -0.296 -0.128
                                       0.747
                                              0.575
                                                    0.333
**
                                                    0.386
                                                                    0.10E 05
                                                            211.67
**
        -3445.482 -0.947 -0.296 -0.128
                                       0.637
                                              0.667
                                                                                     **
       -2387.860 -0.947 -0.296 -0.128
                                       0.609
                                              0.687 0.397
                                                            213.91
                                                                    0.10E 05
44
                                      0.578
                                              0.707
                                                     0.409
                                                            216.04
                                                                    0.10E 05
                                                                                     **
       -3326.640 - 0.947 - 0.296 - 0.128
**
                                                    0.420
                                                           218.32
                                                                    0.10E 05
                                                                                     **
        -3265.416 -0.947 -0.296 -0.128
                                      0.546 0.725
6 tt
                                                                    0.10E 05 -
                                                                                     **
                                                            143.00
                                       0.948 -0.277 -0.157
        4592.629 -0.946 -0.297 -0.129
                                                                                     **
                                                                    0.105 05
        4653.852 -0.946 -0.297 -0.129
                                       0.959 -0.245 -0.139
                                                            145-16
**
        4711.473 -0.946 -0.297 -0.129
                                                            147.16
                                                                    0.10E 05
                                                                                     **
                                      0.969 -0.215 -0.121
**
                                                                                     **
                                       0.978 -0.182 -0.102
                                                            149.35
                                                                    0.10F. 05
         4772.691 -0.946 -0.297 -0.129
**
                                       0.985 -0.149 -0.083
                                                                   0.10E 05
                                                            151.49
         4833.914 -0.946 -0.297 -0.129
**
                                                                   0.10F 05
                                                                                     **
      4891.535 -0.946 -0.297 -0.129
                                      0.991 -0.118 -0.065
                                                            153.73
**
                                                                   0.105 05
                                                                                     **
        4952.758 -0.946 -0.297 -0.129
                                       0.995 -0.085 -0.046
                                                            155.95
**
         5013.980 -0.946 -0.297 -0.129
                                       0.998 -0.052 -0.027
                                                                   0.10F 05
                                                            158.12
**
                                                                                     * *
                                                           160.31
                                                                   0.10E 05
         5071.602 -0.946 -0.297 -0.129
                                       1.000 -0.020 -0.009
                                                                                     **
         5132.824 -0.946 -0.297 -0.129
                                       1.000 0.013
                                                    0.011
                                                            162.38
                                                                   0.105 05
**
                                                            166.82- 0.10E 05
                                                                                     **
         5251.664 -0.946 -0.297 -0.129
                                       0.996 0.078
                                                    0.048
**
                                                            168.84
                                                                   0.10E 05
                                                                                     **
                                       0.991 0.112 0.068
**
         5212.887 -0.946 -0.297 -0.129
                                                                    0.10E 05
**
         5374.109 -0.946 -0.297 -0.129 0.986 0.145
                                                    0.087
                                                            171.24
                                                                                     **
                                                                                     **
4*
**
                                                                                     **
立立
                                            **
                                                                                     ..
**
                                                                                     **
**
                                                                                     **
**
                                                                                     **
                                                               DISP
        CFCINT=DCC22 WHAT NOW
                                           CALL DISPLAY
                                        M S A D *******************
                                                                                     **
••
                                     BISPLAY
**********
```

Figure 5-5 (Continued)

```
- - ERROR STATISTICS - --
       - CURRENT - L'TERATION NUMBER- --- -
                                  MEAN RES
                                                STD. DEV TOTAL WGT
                                   (DEG)
                                                 (D@G)
                                   -0.0068
                                                  0.1037
                                                                 - 500000.13
                                   -0.1045
                                                  0.4741
                                                                    81704.88
                                   -0.7565
                         - 3
                                                  0.8729-
                                                                    - 823.17
                        TOTL
                                   -0.0216
                                                  0.2092
                                                                   582528.13
                                   -0-0149
                        --- 1
                                                  0-1266-
                                                                  1031864.38
                          2
                                   -0.0062
                                                  0.1044
                                                                   370000.13
                        TOTL
                                   -0.0126
                                                  0.1212
                                                                  1401864.00
                                                                  1984392.00
                        STAT
                                   -0.0153
                                                   0.1524
* *
                                         Y S A D
```

Figure 5-6

```
CUMULATIVE STATE VECTOR
         CURRENT ITERATION NUMBER
++
*
                                                   BIASS
                                                            BIAS4
                                E (AS1
                                         BIAS2
        INTEG ALPHA
                       DELTA
         NUM (DEG)
C 275.000
1 275.043
                                                            (DEG)
                                                                     (DFG)
                                                   (DEG)
                                (DEG)
                                         (DEG)
                       (DEG)
                                                             0.0
                                                                       0.0
                                  0.0
                                          0.0
                                                      0.0
                        55.000
•
                         54.866
                                   0.043
                                           -0.134
                                                      0.069
                                                              -0.132
                                                                       -0.727
**
**
                                         M S A D
                                      DISPLAY
```

Figure 5-7

```
M S A D
                         *********** -- D- [+5] P--E- A--
 .
                               CLASS I RESIDUALS AND WEIGHTS --
                                                                                            **
**
                                                                                            **
         CURRENT ITERATION NUMBER
 **
             CLASS-1 ----
                            --- CLASS--1- ---
                                                 CI-ASS--1 -- ---
                                                                   CLASS V...
**
             ANGLES
                               CALCULATED
                                                 DESTRUME
                                                                   WEIGHTS
              0.8910F 02
                                0.8905F 02
                                                  0.47216-01
                                                                     0.0
**
               0.8897E 02
                                 0.8905E 02
                                                  -G.75908-01
                                                                     0.0
**
              0.8909€ -02
                                -0.8905€ 02
                                                ----0.3738F-01----
                                                                  **
               0.8912E 02
                                 0.89058.02
                                                  0.6743E-01
                                                                     0.0
              - 0.8893F -02
                           ---- 0.8905E 02-
                                                 --0-1208E-00-
                                                                     0.0
**
               0.8909E 02
                                 0.8905E 02
                                                   0.4630F-01
                                                                     0.0
                                                                                            **
44
               0.8910E 02
                                 -0.8905E 02
                                                   0.5623F-01-
                                                                    ...0.0
                                                                                            --
**
               C+8887F 02
                                 0.89058 02
                                                  -0.1796F 00
                                                                     0.0
44
                                                 -0.7951E-01
              · C.8897E 02---
                                0.8905F 02
                                                                     0.0---
**
               0.8926E 02
                                 0.8905E 02
                                                  0.2148E 00
                                                                     0.0
**
               0.8896E 02
                                -0.8305E 02 -
                                                  -0.8443E-01
                                                                     -0-0
               0.89095 02
                                 0.8905H 02
                                                   0.4475E-01
                                                                     0.0
**
              -0.8922E 02
                                 .0.8905E 02
                                                   0.17745 00
                                                                     0.0
                                                                                            **
**
               0.8891E 02
                                 0.8905E 02
                                                  -C-1410E 00
                                                                     0.0
                                                                                            **
**
               0.8914F 02
                                0.89058-02
                                                  0.97415-01
                                                                    . .0 . 0.
**
               0.8925E 02
                                                   0.2018E 00
                                                                     0.0
                                 0.89056 02
                                                                                            **
**
               C.8900€ 02
                                 0.89055 02
                                                  -0-4295F-01-
                                                                    0.0
                                                                                            **
Δ±
               0.8914E 02
                                 0.8905E 02
                                                  0.93925-01
                                                                     0.0
                                                                                            **
**
               0.8908E 02
                                 0.8905E 02
                                                   0.30448-01
                                                                     0.0
**
               0.8888E 02
                                 0.89055 02
                                                  -0.1678E 00
                                                                     0.0
                                                                                            **
44
               G.8900E 02
                                 0.8905F 02 -
                                                  -0.4437E-01
                                                                     0.0
                                                                                            **
**
               0.8905€ 02
                                 0.89055 02
                                                   0.7767F-02
                                                                     0.0
                                                                                            **
               0.8892F 02
                                 0.8905E 02
                                                  -0.1247E 00-
                                                                     0.0
                                                                                            **
**
               G.RABOF Ó2
                                 0.8905E 02
                                                  -0.1567E 00
                                                                     0.0
                                                                                           **
**
              0.8909E 02
                                 0.8905E 02
                                                   0.4514E-01
                                                                     0.0
                                                                                            **
               0.8889E 02
                                 0.8905E 02
                                                  -0.1510F 00
                                                                     0.0
                                                                                            **
              0.89165 02
                                 0.8905E 02
                                                   0.1123F 00
                                                                     0.0
**
               0.8904E 02
                                 0.89055 02
                                                  -0.3067E-02
                                                                     0.0
                                                                                            **
**
               0.8901€ 02
                                 0.8905F 02
                                                  -0.38535-01
                                                                     0.0
                                                                                            **
**
              0.8886€ 02
                               C.8904E 02
                                                  -0.1856E 00
                                                                     0.0
**
              0.8897F 02
                                 0.8904E 02
                                                  -0.7016E-01
                                                                     0.0
                                                                                           **
**
               0.8904E 02
                                 0.8904E 02
                                                  -0.3510E-02
                                                                     0.0
                                                                                           **
44
              0.88946 02
                                0.8904€ 02
                                                  -0.1084E 00
                                                                     0.0
              0.8908% 02
                                C.8904F 02
                                                   0.3622F-01
                                                                     0.0
                                                                                           **
**
              0.8916E 02
                                 0.89048 02
                                                   0.11055 00
                                                                     0.0
                                                                                           **
**
              0.8912E 02
                                0.89048 02
                                                  0.74758-01
                                                                    0.0
                                                                                           女女
**
              0.88895 02
                                0.8903F 02
                                                  -0.1388F 00
                                                                     0.0
**
              0.8910E 02
                                0.89038 02
                                                   0.69555-01
                                                                     0.0
                                0.8903E 02
**
              0.89058 02
                                                  0.1967E-01
                                                                     0 - 0
**
              0.89012 02
                                0.89039 02
                                                  -0.18596-01
                                                                     0.0
*
              C.3895€ 02
                                C.89038 02
                                                  -0.7787E-01
                                                                     0.0
                                                                                           * *
              0.8911F 02
**
                                0.8903F 02
                                                  0.80326-01
                                                                     0.0
                                                                                           **
±±
              0.89128 02
                                0.8903# 02
                                                  0.92678-01
                                                                    0.0
                                                                                           **
**
              0.8890E 02
                                0.8903F 02
                                                 -0.1297E 00
                                                                     0.0
        CFCINT=GSTATE WHAT NOW
                                  NEXT
                                              CALL DISPLAY
                                                                    DISP
                                                                                           **
                                           M S A D
                                        DISPLAY
```

Figure 5-8

```
MSAD
****
                                                       ********* 73.179.12.16.11
                                       DISPLAY
海难存亡 古古年军中自有有为自由安全亦称 电电容存储水电路公司
                             CLASS 1 RESIDUALS AND WEIGHTS
                                                                                         **
÷
                                                                                         **
本水
         CLARENT ITERATION NUMBER
**
* *
                                               CLASS 1
                                                                 CLASS 1
                                                                                         **
            CLASS 1
                             CLASS 1
**
                                                                 WEIGHTS
                                               RESIDUALS
            ANGLES
                              CALCULATED
**
                                                                                         * *
                                0.8903F 02
                                                 0.3989E-01
                                                                   0.0
              C.8907E 02
**
                                                                                         **
                                0.39028 02
                                                 0.3239E-01
                                                                   0.0
**
              0.8906E 02
                                                -0.7793E-01
                                                                   0.0
                                                                                         **
                                0.89026 02
              0.8895E 02
*
                                                                                         **
                                                -C.12895-01
                                                                   0.0
                                0.8902E 02
              0.8901E 02
**
                                0.8902E 02
                                                 0.1812E 00
                                                                   0.0
              0.89216 02
**
                                                                                         **
                                                                   0.0
                                0.3902E 02
                                                -0.1249E 00
**
              S0 30688*0
                                                                                         **
                                                 0.3672F 00
                                                                   0.0
              0.8601F 02
                                0.85645 02
**
                                                 0.35915 01
                                                                                         **
                                                                   0.0
                                0.85648 02
              C.8923E 02
4 *
                                                -0.1345F 00
                                                                   0.0
              0.85658 02
                                0.6578E 02
4.4
                                                -0.2850% 01
                                                                   0.0
                                0.85795 02
              0.82945 02
                                                                                         6 xk
                                                 0.42725-02
                                                                   0.0
                                0.8593E 02
              0.8594# 02
*
                                                                                         **
                                                -0.4263E 01
                                                                   0.0
                                0.8594% 02
              0.8167E 02
**
                                                 0.42345 00
                                                                   Q = Q
                                0.86085 02
              0.8651E 02
± ±
                                                 0.1025F 01
                                                                                         **
                                                                   0.0
              0.87116 02
                                C.8608E 02
**
                                                                                         **
                                                 0.17645 01
                                                                   0.0
              0.9801E 02
                                0.86245 02
**
                                                                                         * *
                                0.86255 02
                                                 0.3442E 01
                                                                   0.0
              0.89697 02
*
                                                                                         **
                                                -0.8957E 00
                                                                   0.0
                                0.8641E 02
              0.85528 02
**
                                                                   0.0
                                                                                         **
                                                -0.2256€ 01
                                0.8641E 02
**
              C.8416E 02
                                                                                         **
                                                -0.3954E 00
                                                                   0.0
**
              0.86185 02
                                0.86585 02
                                                                                         **
                                                                   0.0
              0.8495E 02
                                0.86585 02
                                                -0.1630E 01
4 4
                                                                                         **
                                0.8675F 02
                                                -0.2246F 00
                                                                   0.0
**
              0.8653E 02
                                                                                         **
                                0.8576E 02
                                                 0.8062# 00
                                                                   0.0
**
              0.8756€ 02
                                0.8694F 02
                                                                   0.0
                                                                                         **
                                                 0.1169E 00
              C.8705E 02
                                                                                         **
                                                 0.2037E 01
                                                                   0.0
                                0.86945 02
**
              0.8898E 02
                                0.87115 02
                                                 C.7430E 00
                                                                   0.0
**
              0.8785F 02
                                                                                         **
                                                                   0.0
              0.8537E 02 .
                                0.8711F 02
                                                 -0.1741E 01
**
                                                                                         太盘
                                0.8730E 02
                                                -0.2397E 00
                                                                   0.0
**
              0.8706E 02
                                                                                         **
                                                                   0.0
              0.8710E 02
                                0.8731E 02
                                                -0.2022E 00
                                                  0.8797E-01
                                                                   0.0
**
              0.8759E 02
                                0.8750E 02
                                                                                         **
                                0.87500 02
                                                 -0.10105 01
                                                                   0.0
**
              0.8649E 02
                                                                                         **
                                                 0.9076E-01
                                                                   0.0
##
              0.8778E 02
                                0.8769E 02
                                                 0.3311E 00
**
              0.88025 02
                                0.8769E 02
                                                                   0.0
                                                                                         **
                                                 0.1918E 00
                                                                   0.0
              0.8808E 02
                                0.8789F 02
4#
                                                                                         **
                                0.8789F 02
                                                 -0+6189E 00
                                                                   0.0
**
              0.8727E 02
                                                                                         **
                                0.88095 02
                                                                   0.0
**
              0.8765F 02
                                                 -0.4469E 00
                                                                                         **
**
              0.8768E 02
                                0.8810E 02
                                                 -0.4175E 00
                                                                   0.0
                                                                                         **
                                                 -0.2244E 00
                                                                   0.0
**
              0.88078 02
                                0.8829E 02
                                                 -0.5894E 00
                                                                   0.0
                                0.8829E 02
**
              0.6770E 02
                                                                                         **
                                                 G.1486E-01
                                                                   0.0
              0.9852E 02
                                0.8850E 02
4 #
                                0.8850€ 02
                                                 -0.1458% 00
                                                                   0.0
              0.8836£ 02
                                                                                         **
              0.8864E 02
                                0.8871E 02
                                                 -0.7742E-01
                                                                   0.0
**
                                0.8872E 02
                                                 -0.1175E 00
                                                                   0.0
                                                                                         **
**
               0.8860E 02
                                                 -0.48365-01
                                                                   0.0
**
              0.9887£ 02
                                0.88925 02
                                0.8892F 02
                                                  0.1425€ 00
                                                                   0.0
              €.8906€ 02
                                                                                         **
                                                                                         **
                                  NEXT
                                              CALL DISPLAY
                                                                  DISP
        CECINI=GSTATI WHAT NOW
                                          4 SAD
                                                        *********
**********
                                       DISPLAY
*********
```

Figure 5-8 (Continued)

```
DISPLAY
                              CLASS 1 RESIDUALS AND WEIGHTS
**
         CURRENT ITERATION NUMBER
                              CLASS 1
            CLASS 1
                                                CLASS 1
                                                                  CLASS 1
            ANGLES
                              CALCULATED
                                                RESIDUALS
                                                                  WEIGHTS
              0.8988E 02
                                                  0.7500F 00
                                0.891 RF 02
                                                                    0.0
              C.8968E 02
                                0.8913F-02
                                                  C.5483E 00
                                                                    0.0
              0.89535 02
                               0 8935E 02
                                                 0.1-845E -00
                                                                    0.0
              C.8880F 02 :
                                0.89356 02
                                                 -0-4559F 00 .
                                                                    0.0
              0.8911E 02 -
                                0.89565 02
                                                 -0.4442年 00
                                                                    0.0
                                0.89776 02
                                                 -0.39728 00
              0.89385 02
                                                                    0.0
              0.8929E 02
                                0.89785 02
                                                 -C-4857F 00
                                                                    0.0
              0-9079F 02
                                9020E 02
                                                - C.5881F 00
                                                                    0.0
                                                                                          **
              0.89226 02
                                0.9020E 02
                                                 -0.98628 00
                                                                    0.0
              0.87956 02
                                0.90425 02
                                                 -0.24715 01
                                                                    0.0
              0.8917E 02
                               0-90426 02
                                                 -0.1253E -01
                                                                    0.0
ž £
              0.89116 02
                                0.90645 02
                                                 -0.1529E 01
                                                                    0.0
              C.8610€ 02
                                0.9064E 02
                                                 -0.2538E 01
                                                                    0.0
              0.9115E 02
                                0.90848 02
                                                  0.30595 00
                                                                    0.0
**
              0.92465 02 ...
                                0.90850 02
                                                  0.16155-01 --
                                                                    0...0...
--
              0.9067E 02
                                0.9106E 02
                                                 -0.3918E 00
                                                                    0.0
              0.9308F 02
                                0.9106E 02
                                                 0.20208-01--
                                                                    0.0
* *
                                0.91285 02
              0.28485 02
                                                 -0.2800F 01
                                                                    0 = 0
**
              0.92365 02
                                0.9128E 02
                                                 C-1080% 01
                                                                    0.0
              0.8935F 02
                                0.91488 02
                                                 -0.2125E 01
                                                                    0.0
              0.8738E 02
                                0.9169분 02
                                                 -0-4306F 01
                                                                    0.0
              0.9184F 02
                                0-01605-02
                                                  0.1521F 00
                                                                    0.0
              0.89718 02
                                0.9190E 02
                                                 -0.2187年 01
                                                                    0.0
              0.93418.02,
                                C.9190E 02
                                                  0.1510E 01
                                                                    0.0
              0.91465 02
                                0.9229F 02
                                                 -0.83585 00
                                                                    0.0
              0.9230E 02
                                0.9230# 02
                                                  0.5356E-02
                                                                    0.0
**
              0.9456E 02
                                0.92495 02
                                                  0.2067H 01
                                                                    0.0
              0.91128 02
                                0.9250E 02
                                                 -0.1376E 01
                                                                    0.0
              018621F 02
                                OLASSAE DE
                                                 -0.3733E 00 -
                                                                    0.0
**
              0.8482F 02
                                0.85536 02
                                                 -0.76728 00
                                                                    0.0
              0.8552E 02
                                0.85738 02
                                                 -0.2076E 00
                                                                    0.0
             0.6513F 02
                                0.85738 02
                                                 -0.6011E 00
                                                                    0.0
                                0.8587F 02
             . 0-8594E 02
                                                 -.C.7382F-01
                                                                    0.0
              0.8772€ 02
                                0.85878 02
                                                  0.1848E 01
                                                                    0.0
              C.8593E 02 --
                                0.8603E 02
                                                 -0.96775-01
                                                                   .0.0
              0.9004E 02
                                0.8603E 02
                                                  0.4009F 01
                                                                    0.0
              0.86885 02
                                0.8619E 02
                                                  0.6907F 00
                                                                    0.0
              0.8904E 02
                                0.8619E 02
                                                  0.28476 01
                                                                    0.0
              0.8644E 02
                                0.86358 02 -
                                                 C-8994E-01-
                                                                   .. 0.0
              0.8581E 02
                                0.86355 02
                                                 -0.53738 00
**
                                                                    0.0
              0.8680F 02
                                0.8652E 02
                                                  0.27746.00
                                                                    0.0
              0.85498 02
                                0.86526 02
                                                 -0.1035E 01
                                                                    0.0
              0.8631E 02
                                0.8670F 02
                                                 -0.39325 00
                                                                    0.0
              0.89298 02
                                0.8670E 02
                                                  0.2589E 01
                                                                    0.0
        CFCINT=GSTAT1 WHAT NOW
                                             CALL DISPLAY
                                                                   DISP
                                          M S.A.D.
                                       DISPLAY
```

Figure 5-8 (Continued)

```
******
******
                                        MSAD
                                                   - ********* 73.179.12.16.16
                                     DISPLAY
     *******
**
                            CLASS 1 RESIDUALS AND WEIGHTS
                                                                                     **
**
                                                                                     **
* *
       · CURRENT ITERATION NUMBER
                                                                                     **
                                             CLASS 1
                                                              CLASS 1
                            CLASS 1
           CLASS 1
**
                                             RESIDUALS
                                                              WEIGHTS
                            CALCULATED
           ANGLES
**
                                                                0.0
                              0.869.7E 02
                                              -0.2655E 00
             0.8661E 02
                                              -0.5832E 00
                                                                0.0
                              0.8688E 02
              0.86295 02
**
                                                                                     **
                              0.8706F 02
                                              0.50475 00
                                                                0.0
             0.87576 02
4
                                                                                     **
                                              -C-3108E-01
                                                                0.0
                               0.8707E 02
             0.8703E 02
                                                                                     **
                                                                0.0
                              0.8726E 02
                                               0.1647E 01
             0.8890E 02
                                               0.60495 00
                                                                0.0
                              0.8726E 02
              0.8786E 02
                                                                                     **
                                                                0.0
                                              -0.1780E 00
             0.8726E 02
                              0.8744E 02
                                                                                     **
                                              -0.4494E 00
                                                                0.0
                               0.8744E 02
             0.8699E 02
**
                              0.87645 02
                                               0.48955-01
                                                                \mathbf{0} \bullet \mathbf{0}
              0.8769E 02
                              0.8764E 02
                                               0.46568 00
                                                                0.0
              0.8811E 02
                                                                                     * *
                              0.8784E 02
                                              -0.3355E-01
                                                                0.0
              0.8781E 02
**
                                                                0.0
                                              -0.1561E 00
              0.8769€ 02
                               0.8785E 02
**
                              0.8564E 02
                                              -0:1492E 00
                                                                0 + 0
              C. 6549E 02
**
                               0.65798 02
                                               0.6923F 00
                                                                0.0
              0.86485 02
                                                                                     **
                                               0.22190 01
                                                                0.0
                              0.8594€ 02
              0.8816E 02
**
                                                                                     **
                                               0.20958 00
                                                                0.0
              0.8629E 02
                               0.8608F 02
**
                                               0.9355# 00
                               0.8625E 02
                                                                0.0
              0.8718E 02
                                              -0.4552E-01
                                                                0.0
                              0.8641F 02
              0.8637E 02
**
                              0.86585 02
                                              - 0.6104E 00
                                                                0.0
              0.8719E 02
                                              -0.95048 00
                                                                0.0
                                                                                     **
                               0.86758 02
              C.8580E 02
                                                                                     **
                                              -0.1187E 01
                                                                0.0
                               0.8694F. 02
              0.8575E 02
44
                                              -0.29435 00
                                                                \Omega = \Omega
                               0.8730E 02
              0.8701E 02
                                                                                     **
                                              -0.37395 00
                                                                0.0
                              0.87698 02
              0.9731E 02
                                                                                     44
                                              -0.5591E 00
                                                                0.0
                               0.8809E 02
              0.87545 02
                                              -0.1002E 01
                                                                0.0
                               0.8913E 02
              0.88138 02
                                              -0.2523E 01
                                                                0.40
                               0.8935E 0≥
              0.8683E 02
                                                                                     **
                                              -0.3051E 01
                                                                0.0
                               0.89565 02
              0.8651E 02
                                                                                     **
                                              -0.85095 00
                                                                0.0
              0.8892E 02
                               0.89785 02
**
                                                                                     **
                                                                0.0
                               0.9020E 02
                                               C.2114E 01
              0.9232E 02
**
                                               0.21525 01
                                                                0.0
                               0.90645 02
              0.92798 02
¢×
                                                                                     * *
                                               0.1587E 01
                                                                0.0
                               0.90858 02
**
              0.9243F 02
                                               0.18908 01
                                                                0.0
                                                                                     **
              0.92955 02
                               0.91065 02
                                                                                     **
                                                                0.0
                                               0.8186E 00
              0.9272F 02
                               0.9190€ 02
**
                               0.9209E 02
                                               -C.24C4F 00
                                                                0.0
              0.91858 02
44
                                                                                      **
                                               -0.1729E 00
                                                                 0.0
                               0.9230E 02
              0.9212F 02
                                               -0.2939E 00
                                                                0.0
                                                                                     **
                               0.9250F 02
              0.9220E 02
                                                                                      **
                                                                0.0
                                               -0.2919E 00
                               0.85585 02
              0.8529E 02
**
                                               -0.1127E 00
                                                                0.0
              0.8562F 02
                               0.8573E 02
                                                                                      * *
                                                                 0.0
                               0.85875 02
                                               -0.4033@ 00
**
              0.85478 02
                                                                                      * *
                               0.86035 02
                                               -0.11645 01
                                                                 0.0
              0.8487E 02
                                               -0.1790E 00
                                                                 0.0
                               0.86198 02
              0.8601E 02
* *
                                                0.4881E 00
                                                                 0.0
              0.8684E 02
                               0.86358 02
**
                                                0.1586F 01
                                                                 0.0
                               0.8652E 02
              0.88118 02
                                                                                      **
                                               -0.19639 01
                                                                0.0
                               0.8670F 02
              0.84746 02
**
                                                                                      * *
                                                                OISP
                                                                       1 DE
                                            CALL DISPLAY
        CECINIEGSTATI WHAT NOW
                                NEXT
乡业
                                                      ********
    MSAC
                                                      ********
DISPLAY
```

Figure 5-8 (Continued)

```
-CLASS 1 RESIDUALS AND WEIGHTS ----
     --- CURPENT-ITERATION-NUMBER-
                                          CLASS 1-CLASS 1-
           CALCULATED -
           ANGLES
                                             RESIDUALS .
                                                             WEIGHTS
             0.8695E 02
                                                                                    . 44
                              0.8688E 02
                                              0.77166-01
                                                              --0.0
             0.8851E 02
                              0.8706E 02
                                              0.1448F 01
                                                               0.0
            ···0--87876--02----
                          -----0-48744F-02 -
                                          ....0.0-
                                             -0.7256E 00
                              0.8764E 02
             0.8691E 02
                                                               0.0
**
             0.8831E-02-
                             -0.8785E-02
                                           -----0-4672E--00-----
                                                           . ...... O. O.
                                                                                    **
*
                                                                                    **
                                                                                    **
                                                                                   ....±
                                                                                    **
                                                                                    * *
                                                                                    * *
**
$ è
**
**
**
                                                                                    **
                                                                                    **
**
                                          CALL DISPLAY
**
                                       M 'S A D
                                     DISPLAY
```

Figure 5-8 (Continued)

```
********
                                        MSAD
                                                     *******
DISPLAY
                                                     ********* 73.179.12.16.35
                                                                                     **
                            CLASS 2 MESIDUALS AND WEIGHTS
**
                                                                                     **
**
                                                                                     **
         CURSENT ITERATION NUMBER
**
                                                                                     **
**
            CLASS 2
                            CLASS 2
                                             CLASS 2
                                                              CLASS 2
                                                                                     **
**
            ANGLES
                            CALCULATED
                                             RESIDUALS
                                                              WEIGHTS
**
              0.1423E 03
                              0.1424E 03
                                              -0.5115E-01
                                                                0.0
             0.14218 03
                              0.14245 03
                                              -0.30718 00
                                                                0.0
                                                                                     **
*
             0.1446E 03
                              0.1446F 03
                                              0.2983F-01
                                                                0 - 0
                                                                                     **
* *
             0.1451E 03
                              0.1446E 03
                                               C.5007F 00
                                                                0.0
                                                                                     * *
                              0.1468F 03
**
              0.1468E 03
                                              -0.6348E-02
                                                                0.0
                                                                                     **
**
             0.1477E 03
                              0.1468F 03
                                              C.8401E 00
                                                                                     **
                                                                0.0
**
             0.14885 03
                              0.14896 03
                                              -C.6879E-01
                                                                0.0
                                                                                     **
* #
             0.1488E 03
                              0.1489E 03
                                              -0.14216 00
                                                                                     **
                                                                0.0
5 &
             0.1509E 03
                              0.1511E 03
                                              -0.2078F 00
                                                                ·0 • 0
                                                                                     **
             0.1508E 03
                              0.15115 03
                                              -0.3329E 00
                                                                0.0
                                                                                     **
**
             0.1535% 03
                              0.1533€ 03
                                               0.1499F 00
                                                                0.0
                                                                                     **
**
             0.1538E 03
                              0.1534F. 03
                                               0.4465E 00
                                                                0.0
                                                                                     **
             0.1555E 03
                              0.1554E 03
                                               0.59626-01
                                                                0.0
             0.1558F 03
                              0.15548 03
                                               0.31785 00
                                                                                     **
                                                                0.0
**
             0-1577F 03
                              0.1576€ 03
                                               0.78525-01
                                                                0.0
                                                                                     **
**
             0.1576E 03
                              0.1577E 03
                                              -0.10425 00
                                                                0.0
**
             0.1598E 03
                              0.1598E 03
                                              -0.6729E-02
                                                                0.0
                                                                                     **
             C.1596E 03
                              0.1599# 03
                                              -0.2866F 00
                                                                0.0
                                                                                     **
**
             0.1617E 03
                                              -0.1746E 00
                              0.1619€ 03
                                                                0.0
                                                                                     **
*
             0.1623F 03
                              0.16198 03
                                               0.38268 00
                                                                                     **
                                                                0.0
**
             0.1642E 03
                              0.1641E 03
                                            · 0.77-21E-01
                                                                0.0
                                                                                     **
**
             0.1642E 03
                              0.1642E 03
                                              0.6802E-01
                                                                0.0
                                                                                     **
             0.1663€ 03
                              0.1663E 03
                                              -0.3262E-01
                                                                0.0
                                                                                     **
**
             0.1666E 03
                              0.1664E 03
                                              C.2781E 00
                                                                                     **
                                                                0.0
**
             0.1683E 03
                              0.1684E 03
                                              -0.7213E-01
                                                                0.0
                                                                                     **
             0.1683E 03
                              0.1684E 03
                                              -0.1311E 00
                                                                0.0
                                                                                     **
**
             0.1706E 03
                              0.1706E 03
                                              -0.16175-01
                                                                0.0
                                                                                     **
* *
             0.1709E 03
                              0.1707E 03
                                               0.28325 00
                                                                                     **
                                                                0.0
**
             0.1730F 03
                              0.1728E 03
                                              0.149CE 00
                                                                0.0
#
             0.1730E 03
                              0.17295 03
                                               0.1361E 00
                                                                                     **
                                                                0.0
             0.1749E 03
                              0.1749E 03
                                               0.1169E-01
                                                                0.0
                                                                                     **
**
             0.1752E 03
                              0.17495 03
                                               0.22318 00
                                                                0.0
**
             0.1771E 03
                              0.1771E 03
                                               0.2420E-01

                                                                0.0
44
             0.1773E 03
                              0.1771E 03
                                               0.1735E 00
                                                                0.0
                                                                                     **
             0.1793E 03
                             -0.1793E-03
                                              -6.5240E-01
                                                                0.0
                                                                                     **
**
             0.1794E 03
                              0.1794E 03
                                               C.88C7E-01
                                                                0.0
                                                                                     **
4*
             0.1814E 03
                              0.1814E -03
                                              -0-2660E-01
                                                                0.0
                                                                                     **
**
             0.1816F 03
                              0.1814F 03
                                               0.2194E 00
                                                                0.0
                                                                                     **
             0.1838E 03
                              0.1836€ 03
                                           ----- 0.2394E-00----
                                                                                     **
                                                                0.0
**
             0.1838E 03
                              0.1836€ 03
                                               0.1668E 00
                                                                0.0
**
             0.1858E 03
                              0.18585 03
                                              - 0.3688E-01----
                                                               0.0
                                                                                     ...
             0.1857E 03
                              0.1858E 03
                                             -0.160SE 00
                                                                0.0
                                                                                     **
             0.1878E 03
                              0.18796 03
                                              -0.8949E-01
                                                                0.0
                                                                                     **
             0.1900E 03
                              0.1901E 03
                                              -0.7481E-01
                                                                0.0
                                               ----
                                                                                    **
       CFCINT=GSTAT1 WHAT NOW
                              NEXT
                                           CALL DISPLAY
                                                               DISP
                                          **********
                                        MSAD
************
                                     D I S P L A Y - *********************
```

Figure 5-9

```
CLASS 2 RESIDUALS AND WEIGHTS
          CURRENT ITERATION NUMBER
                                                   **
             CLASS 2
                            CLASS 2
                                                  CLASS 2
                                                                     CLASS 2
             ANGLES
                               CALCULATED
                                                  RESIDUALS
                                                                     METCHIC
               0-1900E 03
                                  0.1901E 03
                                                   -0.8972E-01
                                                                       0.0
**
               0.1944F 03
                                  0.1944E 03
                                                    0.1996E-01
                                                                       0.0
44
               0.1943E 03
                                  0.1944E 03
                                                   -0.8043E-01
                                                                  .... - 0.0
               0.1963E 03
                                  0.1966F 03
                                                   -C-2932E 00
                                                                       0.0
**
               0+1965E -03-
                                  0.1966E 03
                                                   -0.1052E-00
                                                                       0.0
               0.19878 03
                                  0.1988E 03
                                                   -0.7863E-01
                                                                       0.0
**
               0.1986E 03
                                  0.19886 03
                                                   -0-1971F 00
                                                                      .0-0
               0.2009E 03
                                                    C-3357F-03
                                  0.2009E 03
                                                                       0.0
                                                                                              **
**
               0.2008E 03
                                0.200/JE 03
                                                   -G.4671E-01
                                                                       0.0
**
               0.2031E 03
                                  0.20318 03
                                                   -0.3220E-02
                                                                       0.0
**
               0.2030E 03
                                 -0-2031E 03
                                                   -0.82236-01
                                                                                              **
                                                                       0.0
               0.2051F 03
                                  0.2053E 03
                                                   -0.1415E 00
                                                                       0.0
**
                                                   -0.1982E-01
               0.2053E 03
                                  0.2053E 03
                                                                       0.0
**
               0.2073E 03
                                  0.2073E 03
                                                   -0.5157E-01
                                                                       0 - 0
                                                                                              **
              - 0.2093E 03-
                                 0.20958 03
                                                   -0.2086E 00
                                                                       0.0
**
               0.2096E 03
                                  0.2096E 03
                                                   -0.3052E-02
                                                                       0.0
* *
               0.2117E 03
                                  0.2118E 03
                                                   -0.2393F-01
                                                                       0.0
**
               0.2117E 03
                                 0.2118F 03
                                                   -0.56175-01
                                                                       0 = 0
**
               0.2161E 03
                                  0.2160E 03
                                                    0-1154E-01
                                                                       0.0
**
                                                   -0.5402E-02
               0.2161E 03
                                 0.21615 03
                                                                       0.0
**
               0.2181E 03
                                  0.2182E 03
                                                   -0.1144E 00
                                                                       0.0
**
               0.2183E 03
                                 0.21835 03
                                                    0-1711E-01
                                                                       0.0
**
               0.14306 03
                                 0.1429E 03
                                                    0.72945-01
                                                                       0.0
立立
               0.1431F 03
                                 0.1429E 03
                                                    0.1314H 00
                                                                       0.0
**
               0.14518 03
                                 0.14515 03
                                                    0.17815-01
                                                                       0.0
               0.14528 03
                                 0.1451F 03
                                                    0.7498F-01
                                                                       0.0
¢¥
               0-1472E 03
                                 0.1472E 03
                                                   -0.1361E-01
*
               0.14706 03
                                 0.1472E 03
                                                   -0.21998 00
                                                                       0 = 0
**
               0.1494E 03
                                 0.1494E 03
                                                    0-17516-01
                                                                       0.0
**
               0.1491F 03
                                 C-1495F 03
                                                   -0.3646E 00
                                                                       0.0
± ±
               0.1515E 03
                                 0.1516E 03
                                                   -0.9055E-01
                                                                      0.0
**
               0.1513E 03
                                 0.15178 03
                                                   -C.3147E 00
                                                                      0.0
               8.1537E 03
                                 0.1537E 03
                                                   -0.2892E-01
                                                                      0.0
**
               0.15388 03
                                 0.1537E 03
                                                    0.79505-01
                                                                       \mathbf{O} = \mathbf{O}
**
               0.1559E 03
                                 0.1559E 03
                                                    -0.6377E-01
                                                                      0.0
              .0 . 1561E 03
                                . 0.1560F 03
                                                    0.1847E 00
                                                                      0.0
               0.15838 03
                                 0.15815 03
                                                    0.1065F 00
                                                                      0.0
**
               0.1578E 03
                                 0.1582E 03
                                                   -0.33168 00
                                                                      0.0
**
               0.1603€ 03
                                 0.1602E 03
                                                    0.46608-01
                                                                      0.0
               0.1604E 03
                                 0.1603F 03
                                                    0.1172E 00
                                                                      0.0
**
               0.1623E 03
                                 0.1624E-03
                                                   -0.1092E 00
                                                                      0.0
* *
               0.1625E 03
                                 0.1625E 03
                                                   -0.4425E-03
                                                                      0.0
**
               0.1644E 03
                                 0.1646E 03
                                                   -0.2936F 00
                                                                      0.0
               0.1646E 03
                                 0-1647F 03
                                                   -0.1165E 00
        CFCINI=GSTATI WHAT NOW
                                   NEXT
                                               CALL DISPLAY
                                            MSAD
                                         DISPLA
```

Figure 5-9 (Continued)

```
********
                                                        ****
                                          MSAD
     ******
                                      DISPLAY
                                                        ********** 73.179.12.16.40
**
                                                                                         **
4 *
         65 T 2
                              CLASS 2 RESIDUALS AND WEIGHTS
$ $
         CURPENT ITERATION NUMBER
                                                                                         **
* *
                                                                                         **
**
            CLASS 2
                              CLASS 2
                                               CLASS 2
                                                                 CLASS 2
                                                                                         * *
                                                RESIDUALS
4 4
            ANGLES
                              CALCULATED
                                                                 WEIGHTS
**
              0.1668E 03
                                0.1667E 03
                                                 0.5185E-01
                                                                   0.0
                                                                                         **
**
              0.1669F 03
                                0-1668E 03
                                                  0-1307F 00
                                                                   0.0
                                                                                         á.
* =
              0.1689E 03
                                0.1689F 03
                                                -0.6677E-01
                                                                   0.0
*
              0.16888 03
                                0.16905 03
                                                -C.1741E 00
                                                                   0.0
                                                                                         **
**
              0.1712E 03
                                0.1711E 03
                                                 0.57598-01
                                                                                         **
                                                                   0.0
**
              0.17138 03
                                0.1712E 03
                                                 0-1045E 00
                                                                   \mathbf{0} \cdot \mathbf{0}
                                                                                         **
**
              0.1423E 03
                                0.1424F 03
                                                -0.9785E-01
                                                                   0.0
                                                                                         **
**
              0-1447E 03
                                0-1446F 03
                                                 0.9895E-01
                                                                   0.0
# $
              0.1470E 03
                                0.14686 03
                                                 0.1322E 00
                                                                   0.0 -
                                                                                         * *
                                                -0.85135-01
**
              0.1488E 03
                                0.1489E 03
                                                                   0.0
                                                                                         **
**
              0.1509E 03
                                0.15115 03
                                                -0.2500F 00
                                                                   0.0
                                                                                         **
*=
              0.1536E 03
                                0.15335 03
                                                 0.2233E 00
                                                                   0.0
                                                                                         **
              0.15565 03
                                0.15546 03
                                                 0.1304E 00
                                                                   0.0
                                                                                         **
4 ×
              0.1577E 03
                                0.15768 03
                                                 C-1944E-01
                                                                   0.0
                                                                                         * *
**
              0.1597E 03
                                0.1599E 03
                                                -0.1064E 00
                                                                   0.0
                                                                                         **
* 4
             0.1642E 03
                                0.1641E 03
                                                 0.7382E-01
                                                                   0.0
**
              0.1683E 03
                                0.1684E 03
                                                -0.9634E-01
                                                                                         **
                                                                   0.0
              0.17306 03
                                0.17285 03
                                                 0.1433E 00
                                                                   0.0
                                                                                         **
              0.18385 03
**
                                0.18365 03
                                                 0.2027E 00
                                                                   0 \cdot 0
                                                                                         * *
**
              0.1858E 03
                                0.1858E 03
                                                -0.6728E-01
                                                                   0.0
**
              0.1879E 03
                                0.1879F 03
                                                 0.31485-01
                                                                   0.0
                                                                                         **
**
              0.1900E 03
                                0.19015 03
                                                -0-8284E-01
                                                                   0.0
                                                                                         **
              0.1944F 03
**
                                0.19448 03
                                                -0.3021E-01
                                                                   0.0
                                                                                         **
**
              0.1986E 03
                                0.1988F 03
                                                -0.1526E 00
                                                                   0.0
                                                                                         **
**
              0.2008E 03
                                0.2009E 03
                                                -0.48195-01
                                                                   0.0
                                                                                         **
              0:2030E 03
                                0.2031F 03
                                                -0.9065E-01
                                                                                         **
                                                                   0.0
**
              0.2117E 03
                                0.2118E 03
                                                -0.1010E 00
                                                                   0.0
                                                                                         **
**
              0.2139€ 03
                                0.2138E 03
                                                 0.5913E-01
                                                                   0.0
**
              0.2160E 03
                                0.21618 03
                                                 -0.1367E-01
                                                                   0.0
                                                                                         **
**
              0.2183F 03
                                0+2183E 03
                                                 0.55025-01
                                                                                         **
                                                                   0.0
**
              0.1430E 03
                                0-1429E 03
                                                 0.81258-01
                                                                   0 \cdot 0
                                                                                         **
**
              0.1452E 03
                                0.14515 03
                                                 0.2672F-01
                                                                   0.0
**
              0.1472F 03
                                0.1472E 03
                                                -0.5716E-01
                                                                   0.0
                                                                                         **
**
              0.1494E 03
                                0.1494E 03
                                                -0.85726-01
                                                                   0.0
                                                                                         **
* *
              0.1515E 03
                                0.15165 03
                                                -0.1561E 00
                                                                   0.0
                                                                                         **
**
              0.1537E 03
                                0.1537E 03
                                                -0.4963F-03
                                                                   0.0
**
              0.1560E 03
                                0.1559E 03
                                                 0.6653E-02
                                                                   0.0
                                                                                         **
**
              0.1581E 03
                                0.1582E 03
                                                -0.4317E-01
                                                                   0.0
                                                                                         **
**
              0.1603E 03
                                0.1602E 03
                                                 0.6993E-01
                                                                   0.0
                                                                                         **
*
              0.1624E 03
                                0.1624E 03
                                                -0.7016E-01
                                                                   0.0
**
              0.1668E 03
                                0-1667E 03
                                                 0.8301F-01
                                                                                         **
                                                                   0.0
**
              0.1688E 03
                                0.1690E 03
                                                -0.1112E 00
                                                                   0.0
                                                                                         **
**
              0.1712E 03
                                0.1712E 03
                                                 0.7814E-01
                                                                   0.0
                                                                                         **
**
4 4
                                                                                         **
**
        CFCINT=GSTAT1 WHAT NOW
                                             CALL DISPLAY
                                                                  DISP
                                                                         2 DE
                                                                                         **
                                          M S A D
************
                                      DISPLAY
                                                       ********
```

Figure 5-9 (Continued)

```
MSAD
                               PLOT EPTION TABLE FOR DOCONS
* *
         FELLEWING ARE CONDITIONS ENCOUNTERED
54
         IN THIS ITERATION OF CCONS
         FID OCCURS CONVERG -
                                                   NO
**
                                                                                          **
         LID ECCENS DIVERGE
                                                   МΠ
**
         WAS MAXIMUM NUM OF ITERATIONS EXCEEDED
                                                   MI.I
**
                                                   NΩ
         WAS NOTE OUT OF PANCE
                                                                                           * *
                                                   мα
         WAS NUM OF BLASES GREATER THAN 5
**
                                                   NO
         WAS THERE A SINGULAR MATRIX
##
**
         FOLLOWING ARE THE PLUT OPTIONS AVAILAB
         RESIDUAL CLASS 1 TYPE 1 VS. 08SER PLOT
                                                   NΩ
**
         RESIDUAL CLASS 1 TYPE 2 VS COSER PLOT
                                                   NO
**
         RESIDUAL CLASS 1 TYPE 3 VS 09SER PLOT
                                                   NO
         RESIDUAL CLASS 1 TYPE 4 VS DBSER PLOT
                                                   NO
**
         RESIDUAL CLASS 1 TYPE 5 VS OBSER PLOT
                                                   NO
**
         RESIDUAL CLASS 2 TYPE 1 VS DBSER PLOT
                                                   NO
**
                                                   NΩ
         RESIDUAL CLASS 2 TYPE 2 VS OBSER PLOT
                                                                                           **
         FESICUAL CLASS 2 TYPE 3 VS CBSER PLOT
                                                   พก
**
                                                                                          *
         PESIDUAL CLASS 2 TYPE 4 VS OBSER PLOT
                                                   NO
**
         SESTEUAL CLASS 2 TYPE 5 VS DOSER PLOT
                                                   NΠ
                                                                                           **
**
                                                                                           **
                                                   мп
         SUMMARY DISPLAY
**
                                                                                           **
         THE USER HAS THE OPTION TO SET
*
                                                                                           * *
         THE FOLLOWING OCCONS OPERATING OPTIONS
**
                                                                                           **
         IF THESE OPTIONS ARE NOT SET
         ECCENS WILL EXIT WHENEVER AN ERROR
                                                                                           * *
         IS ENCOUNTERED OR WHENEVER THE PROGRAM
**
         CONVERGES
**
                                                                                           **
         REINITIALIZE DCCONS
                                                   MO
                                                                                           **
         CEASE PROCESSING IN DOCUMS
                                                   NO
*
                                                                                           **
**
         THE USER MUST TYPE IN YES IN THE POLLO .
         FIELD TO EXIT FROM THE PLOT OPTION TAB
é si
                                                                                           **
                                                                                           **
                                                    NO
         EXIT FLOT CPTION TABLE
$#
* *
                                                                                           **
                                                                                           **
                                              CALL DISPLAY
                                           MSAD
                                        DISPLAY
```

Figure 5-10

```
********
                               MSAD
    ****** D I S P L A Y
                                                                  **
                  FINAL STATE VECTOR RESULTS FACH CCCONS
**
                                                                  **
**
**
                                                                  **
    CURRENT ITERATION NUMBER
                                                                  **
**
      MAXIMUM NUMBER OF ITERATIONS
                                       5
                                                                  **
      RESIDUAL EDITING CRITERIA
**
                                       0.0
                                                                  **
**
      RESIDUAL EDIT BOUND
                                       1.72513
                                                                  **
                                                                  **
卓华
      CONVENTIONS
                                                                  **
****
       **
     UNITS ARE IN DEGREES
                                                                  **
* *
    - ALPHA(I).DELTA(I) ARE POLYNOMIAL COEFF
                                                                  **
**
                                                                  **
**
**
                                                                  **
## - --- - - - - - - - INITIAL - FINAL
                              EST.
                                     INITIAL FINAL
                                                      EST.
                                                                  **
                                              DELTA ACCURACY
                      ALPHA ACCURACY
**
               AL PHA
                                      DELTA
                                                                  **
**
                     312.844
**
  (0) 275.000
                               0.002
                                      55.000
                                                       0.018
                                                                  **
     . (1)
                                                                  **
**
      121
                                                                  **
**
**
                                                                  **
** --
                                                                  **
             CLASS 1 - CONE
**
                             ANGLES
   e. ...
                                                                  **
     TYPE INITIAL FINAL EST. MEAN RMS
**
**
    TYPE
                                                                  **
**
                                                                  **
**
                                                                  **
            0.0 0.095
**
                               0.005 -0.067
                                               0.104
                       -0.121 0.008
                                     0.040
**
                0.0
                                               0.234
                                                                  **
** :-
       3. . .
              ------
                       -0.060
                               0.051
                                       0.644
                                               0.206
                                                                  **
                       0.0
              0.0
                               0.0
                                       0.0
                                               0.0
                                                                  **
                               0.0 - 0.0
**- -- --
     ----5-- --- O.O
                   -0..0
                                               0..0
**
                                                                  **
** -----
                                                                  **
**
              CLASS 2 DIHECRAL ANGLES
                                                                  **
** .. .
                                                                  **
**
            INITLAL
                      FINAL
                                     MEAN
                                               RMS
                                                                  **
**
              —--⊌IAS----
                       -81-AS -- ACCURACY -- RESIDUAL RESIDUAL
                                                                  **
                                                                  **
**
                             0.0
0.002
0.0
  -7.729
                                               0.123
**
               0.0
                    -0.013
                                       -0.002
                                               0.104
                                                                  **
**
       3....
               - 0-0
                                       9.0
                                               0.0
                                                                  **
                       0.0
                0.0
                               0.0
                                       0.0
                                               0.40
                                                                  **
       5--- -- 0.0
0.0
                                       0.0
                                               0...0
                                                                  **
**
                                                                  **
**
                                                                  **
                                                                  **
**
**
                                                                  **
    - CPOINT=FINDIS WHAT NOW ....
                                CALL DISPLAY: - DISP 1 OF 1-
                                                                  **
***<del>*********************</del>
```

Figure 5-11

SECTION 6 COMPILER OPTIONS - NAME= 'MAIN.GPT=01,LINECNT=60.SIZE=0000K, SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

| C | | | | | 00000050 |
|-----------------------|----------------|-----------------------------|----------------|---|---|
| C 未 安米 水井 市市 | · 本本本中 中央市 本本本 | ****** | * **** | · (本本 考索·埃尔克·华尔克·李安·斯· · · · · · · · · · · · · · · · · · · | |
| C . | | , | | | *00000150 |
| c | 01.000 | | ~ | | *00000200 *00000250 |
| C | SUBROUTIN | AE DECRM | 5 | | 00E00200* |
| c | CALL TRIC S | SECUENCE | | | *400000350 |
| , C. | CALLING S | SEGUENCE | | • | *00000400 |
| c · | | CALL | CCONSIAL P.A | LPEND.ALPCUM.DEL.DELBNO.DELCUM. | *00000450 |
| Ċ | | | | 1.ANG1.WGHT1.IFRST1.NTYPE1.BIASI. | *00000500 |
| Ç . | | | , - | .CALC1.SCOEF1.TIME2.AXIS2.ANG2. | *CCC00550 |
| Č . | | | | E2,81AS2,88ND2.RHOST2.RHO2.CALC2. | * 00000600 |
| Ċ · | | | | F,DRHOSQ.CHNG.STOR1,STOR2,ALPR.DEL | R*00000650 |
| c. | • | .STYPE | 1 STYPE2 BT | YPE,RL,WORK,GWORKO,GWORK4,GWORK5, | *00000700 |
| С | | 811 CUM |) | • | *00000750 |
| C | | | | • | *00600800 |
| C | DESCRIPTI | I CN | | | *00000850 |
| c | | | | | *0000000 |
| С | | | | ON OF GOONES DESIGNED TO OPERATE | *00000950 |
| С | | | | ATELLITE ATTITUDE DETERMINATION | *00001000 |
| ε | | (MSAD) | EXECUTIVE | SYSTEM. | *00001-050 |
| c | | | | • | *00001100 |
| Ç | CCMMON AF | REAS REF | ERENCED | • | *00001150 |
| c | | | | | *00C01200 |
| c | | DCSOPT | GCN1, MASCC | .M.STVEC | +00001250 |
| c | | | 55.0 | | #00001300 #00001350 |
| Ç, | EXTERNAL | REPEREN | CES | • | #40G01350 #40G01440 |
| Ċ · | | 196 14 | AVE SERTING | CHECK.COFSM.FINAL2.GDCCON.GTSIZE. | *00001450 |
| C C | - | | | E.MINO.PTSIZE.SGRT | *00001430 |
| c | ÷ | GISTAT | * MAKO * MESAG | IN S MINO S F 1 O 12LL S GOT I | *00001550 |
| c | STORAGE F | PECULPEM | ENTS | | *00001600 |
| Č | J 1 UKKOL | | | | *00001650 |
| č | | 16.222 | BYTES OF C | DRE STORAGE | #00601700 |
| č | | | | , — · · • · · · · · · · · · · · · · · · · | *00001750 |
| c, | VARIABLES | 3 | | | *00001800 |
| C | | | • | • | #00001850 |
| c | NAME | TYPE. | 1/0 | DESCRIPTION . | *00401900 |
| c . | | | | | *00001950 |
| c . | ALP | A *4 | 1/0 | A PRIORI POLYNOMIAL CHEFFICIENT | S#00002000 |
| c | | | | FOR RIGHT ASCENSION. IN DEGREES | * 00002050 |
| С | | | | ([aEaaRA=ALP(])+ALP(2)*T+ALP(]) | |
| С | , | | | 本T水本2+ALP(4)水T半水3。 WHERE T = | *00002150 |
| С | | | | TIME OF OBSERVATION) | *C0005500 |
| C. | • | | _ | | *00002250 |
| c | ALPOND | -2≉4 | . I | CUNVERGENCE BOUNDS FOR ALP, | *60002300 |
| c | | | | IN DEGREES | *00002350 |
| Č. | | raka | | CHANGE ATTME OF COURTS FOR ALCOTT | *00002400 |
| C | ALPOUM | F#4 | C C | CUMULATIVE RESULTS FOR ALP(1) | *00002450 |
| _ | | | | (E _B G _B , ALPCUM(5) CONTAINS THE VALUE OF ALP(1) OBTAINED FOR | *00002500 *00002550 |
| С | | | | THE FIFTH ITERATION | *00002550 |
| c c | | | | 111% 1 11 11 1 1 EDM 1 2 UN | |
| c c c | | | | | |
| с с с | DF1 | R*A | 170 | A PRIDRI POLYNOMIAL CORFEICIENT | 100002650 |
| 0 0 0 0 | DEL | R*4 | 1/0 | A PRIORI POLYNOMIAL CORFFICIENT | *00002650 5*00002700 |
| | DEL | R#4 | 1/0 | FOR DECLINATION. IN DEGREES | *00002650 S*00002700 *00002750 |
| | DEL | R*4 | 1/0 | FOR DECLINATION. IN DEGREES (1.E., D=DEL(1)+DEL(2)+T+ | *00002650 \$*00002700 *00002750 *00002800 |
| | DEL | R*4 | 1/0 | FOR DECLINATION. IN DEGREES (1.5. D=DEL(1)+DEL(2)+T+ DEL(3)*T**2+DEL(4)*T**3. WHERE | *00002650 \$*00002700 *00002750 *00002800 *00002850 |
| | DEL | R*4 | 1/0 | FOR DECLINATION. IN DEGREES (1.E., D=DEL(1)+DEL(2)+T+ | *00002650 **00002700 **00002750 **00002800 **00002850 **00002900 |
| 0 6 0 0 0 0 0 0 0 0 | | | | FOR DECLINATION. IN DEGREES (1.E., D=DEL(1)+DEL(2)+T+ DEL(3)*T**2+DEL(4)*T**3, WHERE T = TIME OF OBSERVATION) | *00002650 \$*00002700 *00002750 *00002800 *00002850 *00002900 *00002550 |
| 0 6 0 0 0 0 0 0 0 0 0 | DELBNO | R *4 R * 4 | 1/0 | FOR DECLINATION. IN DEGREES (1.E., D=DEL(1)+DEL(2)+T+ DEL(3)*T**2+DEL(4)*T**3. WHERE T = TIME OF OBSERVATION) CONVERGENCE ECUNDS FOR DEL. | *00002650 S*00002700 *00002750 *00002800 *00002850 *00002900 *00002550 *00003000 |
| 0 6 0 0 0 0 0 0 0 0 | | | | FOR DECLINATION. IN DEGREES (1.E., D=DEL(1)+DEL(2)+T+ DEL(3)*T**2+DEL(4)*T**3, WHERE T = TIME OF OBSERVATION) | *00002650 \$*00002700 *00002750 *00002800 *00002850 *00002900 *00002550 |

| 0 0 0 0 | DELCUM | R ≉ A | 0 | CUMULATIVE RESULTS FOR DEL(1) (E.G., DELCUM(4) CONTAINS THE VALUE OF DEL(1) CETAINED FOR THE FOURTH ITERATION) | *00003150 *00003200 \$*00003250 *00003300 *00003350 |
|------------------|---------|--------------|------------|---|---|
| с с | ARGCUM | [*4 | O | ITERATION INDICATOR FOR VALUES IN ALPOUM AND DELCUM | *00003450 *00003450 *00003500 |
| с с | TIME1 | R*4 | I | REFERENCE TIMES FOR CLASS 1 (CONE ANGLE) DATA | *00003550 *00003600 *00003650 |
| 0 0 0 0 | AXIS1 | 尺字4 | 1 | REFERENCE UNIT VECTORS FOR CLASS 1 DATA (DIMENSIONED 3 * NUMBER OF CLASS 1 DBSERVATIONS) | |
| с с с | ANG\$ | R*4 | 1 . | CLASS 1 (CONE ANGLE) GESER- VATIONS, IN DEGREES(0-180) | *00003850 *00003900 *00003950. |
| c c | WGHT1 | R*4 | 1/0 | CLASS 1 WEIGHTS | *00004050 *00004100 |
| C C C | IFRST1 | I*4 | Ī | FOINTERS INDICATING STARTING POSITIONS FOR EACH TYPE OF CLASS 1 DATA IN THE ARRAYS TIME1, AXIS1, ANG1, AND WIGHT! | *0000415C |
| c c c | NTYPE1 | I *4 | ı | NUMBER OF OBSERVATIONS OF EACH TYPE OF CLASS 1 DATA | *00004350 *00004400 *00004450 |
| | BIAS1 | R#4 | 1/0 | ESSENTIAL ESTIMATE OF GIASES FOR EACH TYPE OF CLASS 1 DATA (THE VALUE 9999999. INDICATES THAT NO BIAS IS TO BE DETERMINED FOR THE CORRESPONDING ANGLE TYPE) | #00004500 #00004650 #00004650 #00004750 #00004750 #00004800 #00004850 |
| C C | BBND1 | 只∞4 | I | CONVERGENCE BOUNDS FOR BIAS1 ELEMENTS | *00004900 *00004950 *00005000 |
| | RHOST1 | R *4 | 0 | CLASS 1 STATISTICS RHOST1(1,1) - WEIGHTED SUM OF ANGLE RESIDUALS FOR TYPE 1 DATA RHOST1(2,1) - WEIGHTED SUM OF SQUARES OF ANGLE RESIDUALS FOR TYPE 1 DATA RHOST1(3,1) - SUM OF WEIGHTS FOR TYPE 1 DATA RHOST1(4,1) - MEAN RESIDUAL FOR TYPE 1 DATA RHOST1(5,1) - STANDARD DEVIATION FOR TYPE 1 DATA | #00005050 #00005100 #00005150 #00005200 #00005250 #00005350 #00005350 #00005400 #00005410 |
| 0 0 0 | RHO1 | R*4 | O | RESIDUALS FOR CLASS 1 DATA DEFINED AS OBSERVED MINUS CALCULATED | *00005500 *00005550 *00005600 |
| c c | CALC1 | R*4 | 0 | CALCULATED ANGLES FOR CLASS 1 DATA | *00005700 *00005700 *00005750 |
| c c c | SC DEF1 | 유* ♣ | o | DERIVATIVES OF CLASS & ANGLES WITH RESPECT TO STATE VECTOR ELEMENTS | *00405800 *00405850 *00405940 *00405550 |
| c | TIME2 | R*4 | I | REFERENCE TIMES FOR CLASS 2 (DIHEDRAL ANGLE) DATA | *00006000 *00006050 *00006100 *00006150 |

| | | | | • | |
|------------|-----------|-------------|-----|--|----------------------------|
| С | AXIS2 | R#4 | 1 | REFERENCE VECTORS FOR CLASS 2 | *00906200 |
| С | | • | | OATA(DIMENSION 6*NUMBER OF | * 00006 25 0 |
| С | •: | | • | OBSERVATIONS. THE I TH DIFEDRAL | *00006300 |
| С | | | | ANGLE IS MEASURED FROM VECTOR ' | *00006350 |
| c | | , | , | ((1.1).(2.1).(3.1)) TO VECTOR | *00006400 |
| c. | | • | | ((4.1),(5.1),(6.1)) | *00006450 |
| Č. | | | | | *400006500 |
| Č | ANG2 | R *4 | 1 | CLASS 2 ANGLES. IN DEGREES | *00006550 |
| č | 21102 | | • | (0-360) | *00606600 |
| c | | | | | *00006650 |
| c | WGHT2 | R *4 | r | WEIGHTS FOR CLASS 2 DATA | #00006700 |
| c | · | 1.7-7 | • | | *00006750 |
| c | * EOCTO | I *4 | 1 | POINTERS INDICATING STARTING | *00006800 |
| | IFRST2 | £ ***** | | POSITIONS FOR EACH TYPE OF CLASS | |
| C | , | • | | 2 DATA IN THE ARRAYS TIME2. | *00606900 |
| C | | | | AXIS2.ANG2. AND WGHT2 | *00006950 |
| c | • | | | AXISENNOSE NID BOILE | *00G07000 |
| C . | | | | WINDER OF BOSEDMATICHE OF EACH | +00007050 |
| C. | NTYPE 2 | I #4 | I | NUMBER OF OBSERVATIONS OF EACH | |
| C | | | | TYPE OF CLASS 2 DATA | *00C07100 |
| С | * | | | | *00607150 |
| C. | BIAS2 | F*4 | 1/0 | ESSENTIAL ESTIMATE OF BIASES | *00007200 |
| C | | | | FOR EACH TYPE OF CLASS 2 DATA | *00007250 |
| C. | | | | (THE VALUE 9999999. INDICATES | *00607300 |
| C | | | | THAT NO BIAS IS TO BE CETER- | *00007350 |
| С | | | | MINED FOR THE CORRESPONDING | *00007400 |
| Ç~ | | | | ANGLE TYPE | *00GC7450 |
| C | | • | | | *006C7500 |
| С | 8BND2 | R #4 | 1 | CONVERGENCE BOUNDS FOR BIAS2 | *00007550 |
| C | | | | ELEMENTS | *00607600 |
| С | | | | · · | *00007650 |
| c | RHOST2 | R #4 | O | CLASS 2 STATISTICS | \$60007700 |
| c | | | | RHOST2(1,1) - WEIGHTED SUM OF | * 00007750 |
| č | | | | ANGLE RESIDUALS FOR TYPE I DATA | 1 *00007800 |
| č | | | | RHOST2(2.1) - WEIGHTED SUM OF | *00607650 |
| c. | | | | SQUARES OF ANGLE RESIDUALS FOR | *00007900 |
| č | | · . | | · · | *00007950 |
| Č . | | | | RHOST2(3,1) - SUM OF WEIGHTS FOR | 00080000 |
| č | | * | | TYPE I DATA | *00008050 |
| c | | | | RHOST2(4.1) - MEAN RESIDUAL FOR | *00008060 |
| | | | • | TYPE I DATA | *00008070 |
| Ç · | • | | | RHOST2(5,1) - STANDARD DEVIATION | |
| C | | | | FOR TYPE I CATA | *00008090 |
| C | | | | TON THE I DAIN | *C0CC8100 |
| c · | | mark A | _ | RESIDUALS FOR CLASS 2 CATA | #000C8150 |
| C | RHO2 | R#4 | 0 | DEFINED AS OBSERVED MINUS | |
| С | | | | | C00008200 |
| C - | | | | CALCULATED | *00008250 |
| c · | | | • | | *0068300 |
| С | CALCZ | ₽4 | O | CALCULATED ANGLES FOR CLASS 2 | *000C8350 |
| c . | | | | DATA | *00CC8400 |
| c , | * | | | | *00008450 |
| C . | SCOEF2 | A#4 | 0 | DERIVATIVES OF CLASS 2 ANGLES | *00008500 |
| , C | | | | WITH RESPECT TO STATE VECTOR | *00008550 |
| د | | | | ELEMENTS | 00380900* |
| C | ,, | | | ' | ± 00008650 |
| c · | AVGRHO | 尺字4 | 0 | USED TO STORE AVERAGE RESIDUAL | *00608700 |
| c ' | | | , | MAGNITUDE (DIMENSIONED 2X5) | *00008750 |
| , <u></u> | | | | | 0088000 |
| | COEF | R#4 | ۵ | ARRAY USED FOR COEFFICIENT, | *00008850 |
| Č | | | | COVARIANCE, AND CORRELATION | *00008900 |
| ā : | | | | MATRICIES (DIMENSIONED NSXNS. | *00008950 |
| Č . | | | | WHERE NS = NUMBER OF ELEMENTS | *00009000 |
| c · | i | | • | IN STATE VECTOR) | *00009050 |
| c | | | | - : · · · · · · - · · · · · · · · · · · | *00009100 |
| c. C | DRHOSQ | R #4 | o | WORK ARRAY(DIMENSIONED 13) | *00605150 |
| c | ONITIO SM | 43 T T | _ | The control of the state of the | *00009200 |
| ` | | | | | |

| C | CHNG | 化本本 | . D | WORK ARRAY USED TO STORE THE | * 00009250 |
|-----|-------------|-------------|------------|----------------------------------|---------------------------|
| С | | | | UPDATES TO THE STATE VECTOR | *00669300 |
| c | | | | AFTER EACH ITERATION(DIMENSIONED | |
| C | • | | | 13) | *00009400 |
| C | | | | | *00009450 |
| C, | STOR1 | R#4 | 0 | WORK ARRAY (DIMENSIONED 13) | *00009500 |
| С | | | | | *00009550 |
| Ç | STORS | 日本4 | C | WORK ARRAY (DIMENSIONED 13) | # 00009600 |
| Ç | | | | | *00009650 |
| C | ALPR | R#4 | C | RIGHT ASCENSION(ALP) COEFFI- | #00669700 |
| C | | | | CIENTS. IN RACIANS | *00009750 |
| C. | | | | | *00662600 |
| С | DELR | R *4 | ۵ | DECLINATION(DEL) COEFFICIENTS | * 00009 £50 |
| C | | | | IN RADIANS | * 00009900 |
| Ç | | | | | * 00009950 |
| C | STYPE1 | ₽*4 | 0 | ALPHA-NUMERIC WORK ARRAY | *00010000 |
| С | | | | (DIMENSIONED 13) | *00010050 |
| Ċ | | | | | *00010100 |
| ¢ | STYPE2 | R*4 | 0 | ALPHA-NUMERIC WORK ARRAY | *00010150 |
| c . | | | | (DIMENSIONED 13) | *00010200 |
| C | | | | | #00010250 |
| c | BTYPE | 1 *4 | O. | WORK ARRAY(DIMENSIONED 12) | #00010200 |
| c | | | | | *00010350 |
| c | RL | L # 1 | G | LOGICAL WORK ARRAY (CIMENSIONED | *00G10400 |
| Č | | | | 13) | #00010450 |
| c c | | | | | # 00010500 |
| c | WORK | R#4 | 0 | WORK ARRAY(DIMENSIONED 13) | *40010550 |
| č | | | | | *00010600 |
| c | GWORKO | R#8 | 0 | ALPHA-NUMERIC WORK ARRAY USED | *00010650 |
| č | Q | | • | TO STORE FINAL SUMMARY RESULTS | *00010700 |
| c | | | | FOR DISPLAY | *00010750 |
| č | | | | | *00-01-0800 |
| č | GWCRK4 | 長本4 | 0 | WORK ARRAY USED TO STORE OBSER- | |
| č | 0 | 111111 | _ | VATION NUMBER FOR PLUTTING | *00010900 |
| č | | | | | *00010950 |
| č | GWORK5 | 只本各 | O | WORK ARRAY USED TO STORE (O-C) | *00011000 |
| Ğ | | | • | RESIDUALS FOR PLOTTING | *00011050 |
| ç | | | | | *00611100 |
| č | B11CUM | R*8 | 0 | ALPHA-NUMERIC WORK ARRAY USED TO | |
| č | 22200 | | • | STORE CUMULATIVE BLASES FOR | *00011200 |
| c | | | | DISPLAY | 00011250 |
| č | | | | | *60611300 |
| č | COMMON ARI | FA VARIARII | ES USED IN | ROUTINE | *00011350 |
| č | COMMON AND | CA TANIADE | LO COLS IN | | *00011400 |
| č | VARIABLE | TYPE | DRIGIN | DESCRIPTION | *00011450 |
| c | VARIABLE | 1176 | ORIGIN | | *00011500 |
| č | CPTION | I * 4 | DCSOPT | FLAG ARRAY FOR PLUTTING OPTIONS | |
| c | CFILON | 1.20 | Desari | =0. DO NOT PLOT | *00011600 |
| c | | | | =1, PLOT | *00011650 |
| c | | | | -1, FLUI | *00C11700 |
| | STAITCH | 744 | DECEMBE | FLAG FOR TERMINATING PLOT OPTION | |
| c | FINISH | I * 4 | DCSOPT | TABLE | *00011800 |
| ç | | | | | |
| C | | | | =0, DO NOT TERMINATE | +00011650 |
| C | | | | =1. TERMINATE | *00011900 |
| C | ETNIA! P | T # A | 048007 | ELAC EDD DIEDLAUTHE SUNHARY | *00011950 |
| č | FINALD | I#4 | OCSOPT | FLAG FOR DISPLAYING SUMMARY | *00012000 |
| Ē | | | | DISPLAY | *00012050 |
| c | | | | =0. DO NOT DISPLAY | *00C12100 |
| c | | | | =1. DISPLAY | *00012150 |
| C | | | | ####### D##### | *00012200 |
| C | 1001 | I#4 | GCN1 | FORTRAN DEVICE UNIT FOR SPECI- | *00012250 |
| C | | | | FIED PRINTOUT | *00012300 |
| c | | | | | *00012350 |
| C | NCLAS! | 1*4 | GCN1 | NUMBER OF CLASS 1 DATA TYPES | *00612400 |
| c | | | | | *00012450 |
| C | NCLAS2 | I*4 | GCNI | NUMBER OF CLASS 2 DATA TYPES | +00012500 |

| _ | | | | | | |
|--------|---|----------|---------------|-------------|---|------------------------|
| C C | | NCDF | I 14 4. | GCN1 | MAYTHUM NUMBER OF TYPOLITAGE | *00012550 |
| Ç | | NC. DF | 1-44 | GCMI. | MAXIMUM NUMBER OF ITERATIONS | *00012600 |
| c | | MAXIT | I*4 | GCN1 | MAXIMUM NUMBER OF ITERATIONS | *00012650 *00012670 |
| č | • | PIRALI | 1 | GCI18 | MANTHON MONDER OF THERM TONS | *00012680 |
| č | | IWRT | 184 | GCN1 | INTERMEDIATE PRINTOUT LEVEL | *00012700 |
| Ċ | | • | | - | INDICATOR (SEE REFERENCES 1 & 2 | |
| C | | | | | FOR VARIOUS LEVELS) | *00012800 |
| C | | | | | • | *C0012850 |
| С | • | TZERO | R*4 | GCN1 | REFERENCE TIME | *00012860 |
| С | | | | | | *00012870 |
| C | | IOC | 1 * 4 | GCN1 | RESIDUAL STORAGE INDICATOR | *00012900 |
| Ċ | | | • | | =0, DO NOT STORE RESIDUALS | *00012950 |
| C | | | | | =1, STORE RESIDUALS FOR DIS- | *00613000 |
| C C | | | | | PLAY AND PLOTTING | *00013050 |
| c | | ICALC | 1 4 4 | GCN1 | CALCIN ATER MALLIEC CTODACE THAT | *00013100 |
| c | | 1 CMC? | T. or see | GCMI | CALCULATED VALUES STORAGE INDI- CATORS | = |
| Ĉ | | | | | =0, DO NOT STORE CALCULATED | *00013200 |
| č | | | | | VALUES | *00013300 |
| C | | | | | =1. STORE CALCULATED VALUES | *00013350 |
| C | | | | | FOR DISPLAY | *00613400 |
| С | | | | * | | *00013450 |
| C. | | ICER | I * 4 | G CN1 | DERIVATIVE STORAGE FLAG | *00013460 |
| C | | | | | =0. DO NOT STORE | *00013470 |
| Ċ | | | | | =1. STORE | *00013480 |
| C | | | | • | | * 60013490 |
| C | | SMULT | R*4 | GCN1 | RESIDUAL EDIT CRITERIA (THE | *00013500 |
| 2 | | | | | WEIGHTS OF ANGLES WHUSE MAGNI- | ±00 01 3550 |
| C | | | | | TUDE OF RESIDUAL IS GREATER | *00013600 |
| C | | - | | • | THAN SMULT*(AVERAGE OF RESID- | *00013650 |
| c | | | | | MACATIVE OF THE OFFICE | *00613700 |
| c | | | | | NEGATIVE OF THE RESIDUAL | *00C13750 |
| c c | | NP | I*4 | GCN1 | TOTAL NUMBER OF ELEMENTS IN THE | *00013800 |
| Č. | | | | ~ · · · · · | STATE VECTOR (DEFINED AS 2*NCOF | |
| c | | | | | NUMBER OF BIASES) | *00013950 |
| С | | | | , | | *00614000 |
| C | | I WHERE | 1*4 | GCN1 | CURRENTLY NOT USED | *00014010 |
| C , | | | | | | *00014020 |
| С | | ISTEP | I*4 | GCN1 | CURRENT ITERATION INDICATOR | *00014050 |
| C | | | | | | *00C14100 |
| Č | | ISTOP | I #: 4 | GCN1 | CURRENTLY NOT USED | *00014110 |
| C | | | | | | 00014120 |
| C | | IRET | I#4 | GCN1 | RETURN CODE | *00G14150 |
| C C | | | | | =0. PROCESS CONVERGED | *00014200 |
| Č. | | | | | =%, MAXIT EXCEEDED, PROCESS TERMINATED | *00014250 |
| č | | | | | =2. PROCESS DIVERGED. COR- | *00014300 |
| č | | | | | RECTION ELEMENT GREATER | *00014350 |
| C | | | | | THAN 360 DEGREES | *00014400 *00014450 |
| Ċ | | | | | =3. SINGULAR MATRIX | *00014500 |
| . c | | | | | =4, NUMBER OF BIASES GREATER | *00914550 |
| C | | | | | THAN 5 | *00614600 |
| C | | | • | | =5. NCOF OUT OF RANGE | *00614650 |
| С | | | | | | *00C14700 |
| C | • | ISTAT | I*4 | GCN1 | COVARIANCE/CORRELATION FLAG | *00014710 |
| C | | | | | =0. DO NOT COMPUTE | *00014720 |
| C | | | | | =1. COMPUTE | *00014730 |
| Ċ, | | e enutri | P.4. 4 | C. Maria | 8.4.8 | *00014740 |
| C | | CORMIN | 1*4 | GCNI | DISPLAY INDICATOR FOR CLASS 1 | *00014750 |
| C C | | | | | DATA | *00014800 |
| C | | | | | =0. DO NOT DIŚPLAY =1. DISPLAY | *00014850 |
| Ċ | | | | | -s, niskewi | *00014500 |
| _ | | | | | · | *00014950 |

| | | | | • • • • • • • • • • • • • • • • • • • | |
|----------|-----------|-----------|----------------------|---|--|
| С | CORMAX | 1 *4 | GCNX | 240. C | *00015000 |
| С | | | | VA.A | *00015050 |
| С | | | | · | *00015100 |
| c | | | | •• | *00015150 |
| С | | | | | *00015200 |
| C. | IOPEN | I本本 | MASCUN | 0.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | #00015250 |
| c | | | | =0, NO GRAPHICS DEVICE ACTIVE | _ |
| C | | | | 4, | *00015350 *00015400 |
| C | | | | | *00015450 |
| c | | | | | *00015500 |
| C | DATA TRAN | SMISS | ION | | *00015550 |
| C | | | | | *00015600 |
| c | NAME | READ | /WRITE/CPOINT | D204.14. 19-11 | *00015650 |
| C | | | | | *00015700 |
| c | FTXXF001 | WRIT | E. | | *00015750 |
| c | | | | 77 | *00015800 |
| С | | | | DCCONS INITIAL PARAMETER DISPLAY | |
| c | GCONE 0 | CPOI | NI | | *00015900 |
| c | | | | | #00015950 |
| С | DCCX | CFOI | NŦ | CLASS & DATA OTSPER | *00016000 |
| c | | *** | | CLASS & DATA DISPLAY | *00016050 |
| c | DCCS | CPOI | NI | CEMSS & DATA DISPERT | *00016100 |
| c | | | | COTTON TABLE DICOLAY | *00C16150 |
| C | OPTAB1 | CPQI | NT | OPTION TABLE DISPLAY | *00016200 |
| С | | | | | *00016250 |
| c | RESTRICTI | CNS _ | | COMPARED TO MUST BE COCATED DO | 00E31000* |
| С | | | | COEFFICIENTS MUST BE GREATER OR | *00016350 |
| С | EQUAL | TO S | AND LESS THAN | OR EGUAL TO A | *00016400 |
| C | | | | | *00016450 |
| ε | | | | EMINED, FOR BOTH CLASS 1 AND | *00016500 |
| Ç | CLASS | 2 DA | TA, MUST BE LES | S THAN OR EQUAL TO 5 | *00016550 |
| C | | | | WE ARE WORD AND SERVE | |
| c | 3- ALL C | ALLIN | G SEQUENCE ARRA | YS ARE MSAD ALLOCATED, AND HENCE | *00016650 |
| C | | | | ENSURE THE ALLOCATION SIZE OF | *00016700 |
| C , | WORK | ARRAY | S IS NOT EXCEED | ED• | *00016750 |
| C | | _ | | | *00016800 |
| С | REFERENCE | 5 | | | *00016850 |
| С | | _ | | CHEC AN ITERATINE DISCOUNTIAL | *00016500 |
| C | | Į . | L.R.SCHLEGEL, C | ONES AN ITERATIVE DIFFERENTIAL INIQUE FOR ATTITUDE DETERMINATION | |
| С | | | | | +00017000 |
| C | | | | ATELLITE, IBM FSD REPORT, | *00017050 |
| c | | | CONTRACT NAS 5- | 10022. MAY 1697 | *00017100 |
| С | | _ | SUBJECT AND SUBJ | VATION OF ATTITUCE CETERMINATION | |
| c | | 2. | | FSD REPORT TR-68-8, CONTRACT | *00017200 |
| Ç | | | | Y 1968, PP. 4-14 TO 4-24 | *00017250 |
| 5 | | | NAS S-IUUZZ, MA | 4 1900, PP 4-14 10 4-24 | *00017300 |
| c | | - | DADIO ACTRONOVO | EXPLORER ATTITUDE DETERMINATION | |
| C | | 3. | RADIO ASTRUNUMY | . VOL III. SPIN AXIS ATTITUDE | *·00017400 |
| c - | | | STSIEM (KARAUS) | CONCORM_DACAN THE ECO DECIDE. | *00017450 |
| C | | | | ROGRAM-DYCON, IBM FSD REPORT. | *00017500 |
| C | | | CONTRACT NAS 5- | -10022, MARCH 1969 | *00017550 |
| c | | | CURTEN (| SETTETE CHORDISTING GACKACE. | +00017500 |
| c | | a. | | INTIFIC SUBROUTINE PACKAGE. | *00017650 |
| c | | | | GRAMMER'S MANUAL, ISM FORM NO. | *G0017700 |
| C | | | H20-0205-2 | | *00017750 |
| c | n= | - | | | *00C17800 |
| C | REVISIONS | j | | • | *00017850 |
| C | | | | IC TORON - OPTOINE CONTNO AND | *00417230 |
| c | | I • | | G 1969) - ORIGINAL CODING AND | *00017950 |
| C | | | TESTING | | *0001/950 |
| <u>c</u> | | _ | | IN TOTAL NORTHTOATTON TO CHECK | |
| c | | 2. | ** KNOUP (20 JA | AN 1970) - MODIFICATION TO CHECK | ************************************** |
| Ç | | | | TO PREVENT INC2541 ERRORS DUE TO | *00018150 |
| C . | | | AUSURDLY LARGE | CORRECTION ELEMENTS | *00018200 |
| c | | _ | ٠٠ ٠٠ ـ ـ محرور ـ ــ | AN ANTAL - DEPARENTAL OF ECONO | +00018250 |
| <u>c</u> | | 3• | | AN 1970) - REORDERING OF ERROR | *00018300 |
| C | | | KETURN CUDES IN | ITO ORDER OF SEVERITY | AA4¥ 6240 |

```
±00018350
                                      F. KNOOP (20 FEE 1970) - COMPLETE REVISION TO
                                                                                          *00016400
                                      INCLUDE DIHEDRAL ANGLE DATA
                                                                                          *00018450
                                                                                          #0001F500
                                       J. WHALEN (SUMMER 1972) - REVISION TO GCONES
                                                                                          ±00012550
                                      TO INCLUDE LOGIC FOR INTER-ACTIVE GRAPHICS
                                                                                          *00016600
                                      CAPABILITIES UNDER THE MULTI-SATELLITE ATTITUDE
                                                                                          #000LE650
                                      DETERMINATION SYSTEMS THESE REVISIONS INCLUDE ADDITION OF ARRAYS AND INSERTION OF CALLS TO
                                                                                          *00C18700
                                                                                          *00016750
                                       THE MSAD ROUTINES.
                                                                                          *00018800
                                                                                          *00018850
              ۳
                                      L. FRAKES (13 JULY 1973) - REVISION TO CODE TO INCLUDE ADDITIONAL CALLS TO MSAD ROUTINES AND
                                                                                          ±00018900
              r
              Ċ
                                                                                          *00018950
                                       CHANGE OF LOGIC FOR REINITIALIZATION OF DECONS
                                                                                          *00013000
                                                                                          ******
              c
                                                                                          *******
              SUBROUTINE DCCOMS (ALP, ALPBND, ALPCUM, DEL, DELBND, DELCUM, ARGCUM, TIMEQ0019200
TSN 0002
                   11.AXIS1.ANG1.WGHT1.IFRST1.NTYPE1.BIAS1.BBND1.RHOST1.RHO1.CALC1.SCOG0019250
                   2EF1 .TIME2 .AXI52 .ANG2 .WGHT2 .IFRST2 .NTYPE2 .BIAS2 .EBND2 .RHOST2 .RHO2 .C00019300
                   JALCZ . SCCEF2 . AVGRHO . COEF , DRHOSQ . CHNG. STURI . STORZ . ALPR . DELR . STYPE 1 . S00019350
                   ATYPE2.BTYPE.RL.WORK.GWORKO.GWORK4.GWORK5.B11CUM)
                                                                                           00019400
                     COMMON/GCN1/ICUT, NCLAS1, NCLAS2, NCOF, MAXIT, IWRT, TZERG, IQC, ICALC,
                                                                                            00419450
ISN 0003
                                 IDER, SMULT, NP, INHERE, ISTEP, ISTOP, IRET, ISTAT,
                                                                                            00019500
                                                                                            00019550
                                 CORMINACIONAX
                                                                                            CORTCEAS
/ISN 0004
                    COMMON/STVECT/OLDALP(4).GLODEL(4).OLCOS1(5).OLCOS2(5).
                   1 NEWALP(4) , NEWDEL(4) . NEWBS1(5) . NEWBS2(5)
                                                                                            00019650
                     REAL . NEWALP . NEWDEL . NEW851 . NEW852
                                                                                            00619700
15N 0005
                     COMMON/DCSCPT/ OPTION(10).FINISH.FINALD.IMESG(8)
                                                                                            00016760
TCN 0006
                     INTEGER#4 OPTION FINISH FINALD
                                                                                            00015800
ISN 0007
                    COMMON/MASCOM/ IDUMMY(24), IOPEN
                                                                                            00019650
TSN GCCP
                     FEAL+B STATE STOPE
                                                                                            00019900
15N 0009
                    CATA STOP1/'STOP
ISN 0010
                                                                                            00020000
              c
                     DIMENSION ALP(1), ALPBOD(1), ALPCUM(1), DEL(1), DELEND(1), DELCUM(1),
                                                                                            00021800
ISN 0011
                               ARGCUM(1), TIME1(1).AXIS1(3,1).ANG1(1).WGHT1(1).
                                                                                            00021650
                               IFRST1(1).NTYPE1(1).81AS1(1).88NQ1(1).RHQST1(3.1).
                   2
                                                                                            .00021900
                               RHC1(1), CALC1(1), SCOEF1(NP.1), TIME2(1), AX(S2(6.1).
                                                                                            00021950
                                ANG2(1), WGHT2(1), IFRST2(1), NTYPE2(1), EIAS2(1), BBND2(1).
                                                                                           00622000
                               RHQST2(3.1), RHQ2(1), CALC2(1), SCGEF2(NP,1), AVGREG(2.1),
                                                                                            00022050
                               COEF(NP.NP).DRHOSQ(NP).CHNG(NP).STDR1(NP).STOR2(NP).
                                                                                            00022100
                       ALPR(1).OELR(1).STYPE1(1).STYPE2(1).BTYPE(1).RL(1).WORK(1).
                                                                                            00022150
                                                                                            00622200
                      ANUM(6)
                                                                                            00022250
                    DIMENSION BLASI(6) .BIAS21(6) .AI(4) .DI(4) .RHOT1(5.6) .RHOT2(5.6) .
ISN 0012
                      GWDRK0(1), GWDRK5(1), GWGRK4(1)
                                                                                            00622300
                     REAL WE GWORKO - BIICUM
                                                                                            00622350
ISN 0013
                     INTEGER#4 BTYPE . CORMIN . CORMAX
                                                                                            00022400
ISN 0014
                    DATA TOTAL/"TCTL"/, BLANK/"
                                                    */,ANUH/*
                                                                                           .00022450
ISN 0015
                                                                                            00022500
                    1 5 1, 6, 1/
                     DATA STATZ/*STAT*/
                                                                                            00022550
ISN 0016
                     LOGICAL*1 RL
                                                                                            00022500
ISN 0017
                                                                                            00022650
                     DIMENSION NAME(2,13)
ISN 0018
                                                                                            00022700
                     REAL NAME
ISN 0019
                     DATA NAME / " ALP", "HA 1", " DEL", "TA 1", " ALP", "HA 2", " DEL",
                                                                                            00022750
ISN 0020
                                  *TA 2*, * ALP*, *HA 3*. * DEL*, *TA 3*. * ALP*, *HA 4*, * DEL*, *TA 6*, * BI*, *AS 1*. * BI*, *AS 2*, * BI*,
                                                                                            00822800
                                                                                            00022850
                                  "AS 3"," BI","AS 4"," BI","AS 5" /
                                                                                            00022900
                     CATA RTOD. XEIAS / 57.29578. 9999999. /
                                                                                            00022950
15N 0021
                                             COFSUM. ELKINV. CHECK
                                                                                            00023000
                     EXTERNAL REFERENCES
                                                                                            00023050
                     IF (IWRTEGT.C) WRITE (IOUT.890)
                                                                                            00023100
 TSN 0022
                     IF (IWRT-LT-2) GO TO 170
                                                                                            00023150
 TSN 0024
              C **** WRITE HEADER LINE AND ALL INPUT NON-ARRAY ITEMS
                                                                                            00023200
                     WRITE (18U1,900) NCLAS1,NCLAS2,TZERO,NCOF,MAXIT, [WRT-10U1
                                                                                            00023250
 TSN 0026
              C $##** WRITE INITIAL ATTITUDE COEFFICIENTS AND CORRECTION BOUNDS
                                                                                            00023300
                     MPITE (IBUT.910) (ALP(I).ALPEND(I).DEL(I).DELEND(I).I=1.NCDF)
                                                                                            00023350
 TSN 0027
              C ++** WRITE INITIAL BIAS ESTIMATES AND CORRECTION BOUNDS
                                                                                            00023400
                     IF (NCLASI.LE.O) GO TO 110
                                                                                            00023450
 ISN 0028
                                                                                            00023500
                     ITITLE=1
 15N 003C
                                                                                            00023550
                     DO 100 I±1.NCLASI
 ISN 0031
                     IF (BIASI(I).EC.XBIAS) GD TO 100
                                                                                            00023600
 $500 NRI
                     IF (ITITLE-EG.1) WRITE (IOUT-920)
                                                                                            00023650
 ISN 0034
                     ITITLE=2
                                                                                            00023700
 TSN 0036
                     WRITE (18UT, 940) 1.BIAS$ (1).BBND$(1)
                                                                                            00023750
 ISN 0037
                 100 CONTINUE
                                                                                            00023800
 ISN 0038
                                                                                            00023850
 19N 0039
                 110 CONTINUE
                                                                                            00623900
                     IF (NCLAS2-LE-0) GO TO 130
 ISN 0040
```

```
ITITLE=1
ISN 0042
                                                                                          00023650
                    DO 120 [=1.NCLAS2
ISN 0043
                                                                                          00024000
                    IF (BIASE(I).EQ. XBIAS) GO TO 120
15N 0044
                                                                                          00024050
                    IF (ITITLE .E C.1) WRITE (10UT, 930)
ISN 0046
                                                                                          00024100
TSN 0048
                    ITITLE=2
                                                                                          00024150
                    WRITE (10UT.940) 1.81A52(1).88ND2(1)
ISN 0045
                                                                                          00024200
ISN 0050
                120 CONTINUE
                                                                                          00024250
ISN OCE 1
                130 CONTINUE
                                                                                          00624300
ISN 0052
                    IF (IMRT.LT.3) GO TO 170
                                                                                          00024350
ISN 0054
                    IF (NCLAS1.LE.0) GO TO 150
                                                                                          00024400
                    00 140 1=1 NCLAS1
ISN 0056
                                                                                          00624450
                    J1=1FRST1(1)
ISN 0057
                                                                                          00024500
                    N=NTYPER(I)
ISN 0058
                                                                                          00024550
ISN 0055
                    J2=J1+N-1
                                                                                          00024600
ISN 0060
                    WRITE (10UT, 950) 1,N,J1,J2
                                                                                          00024650
                    IF ([WRT+GE+8+AND+N+GT+0] WRITE ([GUT,970] (J.TIME1(J).(AX[S1(K,J)00024700
ISN 0061
                   1.K=1.3).ANG1(J).WGHT1(J).J=J1,J2)
                                                                                          00024750
                140 CONTINUE
ISN 0062
                                                                                          ODC24800
                150 CONTINUE
ISN 0064
                                                                                          00024650
                    IF (NCLA92.LE.0) GG TO 170
ISN 0065
                                                                                          00024900
                    DO 160 I=1.NCLAS2
ISN 0067
                                                                                          00024950
                    J1 = (FRST2(I)
ISN DOSE
                                                                                          00025000
ISN 0069
                    N=NTYPE2(1)
                                                                                          00025050
ISN 0076
                    J2=J1+N-1
ISN 0071
                    St. 1 (1001,960) I.N. J. J.
                                                                                          00025150
ISN 0072
                    IF (IWRT)GE. E-AND.N-GT.0) WRITE (IOUT.980) (J.TIME2(J).(AXIS2(K.J)00025200
                   1.K=1.6):ANG2(J):WGHT2(J):J=J1.J2)
                                                                                          00025250
                160 CONTINUE
ISN 0074
                                                                                          00625300
ISN: 0075
                170 CONTINUE
                                                                                          00025350
                    DD 180 I=1.5
ISN 0076
                                                                                          00025400
ISN 0077
                180 BTYPE(I)=0
                                                                                          00425450
ISN 0C78
                    DO 190 1=1.13
                                                                                          00925500
ISN 0679
                    STYPE1(1)=BLANK
                                                                                          00025550
ISN 0080
                    STYPE2(I)=BLANK
                                                                                          00625600
ISN OCES
                    STORI(I)+0.
                                                                                          00025650
                190 STOR2(I)#0.
ISN OCE2
                                                                                          00025700
                    NDNE=0
ISN 00E2
                                                                                          00025750
ISN OCE4
                    NTWO=0
                                                                                          00025800
                    STORE DATA FOR MSAD DISPLAY
             C ***** COMPUTE THE NUMBER OF ANGLE BIASES TO BE DETERMINED
                                                                                          00025900
ISN OGES
                   NLC ≠ 0
                                                                                          00425450
ISN GCE6
                    NBIA5=0
                                                                                          00026000
ISN 0087
                    IF (NCLAS1-LE-0) GO TO 210
                                                                                          00026050
ISN OCB9
                    DO 200 I=1.NCLAS1
                                                                                          00025100
ISN DOSC
                    NONE=NONE+NTYPE1(I)
                                                                                          00026150
ISN 0051
                    IF (BIASI(I).EQ.XBIAS) GO TO 200
                                                                                          00926200
ISN 0093
                    NBIAS=NBIAS+1
                                                                                          00026250
ISN 0094
                    NLC=2*NBIAS
                                                                                          00026300
ISN 0095
                    STOR1(NLC-1) = 81A51(1)
                                                                                          00026350
ISN 0096
                    STOR% (NLC) = BBND1(1)
                                                                                          00026400
ISN 0097
                    BTYPE(I)#10+I
                                                                                          00026450
15N 0098
               SOO CONTINUE
                                                                                          00026500
ISN 0099
               210 CONTINUE
                                                                                          00026550
                    IF (NCLAS2.LE.O) GO TO 230
ISN 0100
                                                                                          00026600
                   00 220 I=1.NCLAS2
TSN 0102
                                                                                          00926650
                    NTWO=NTWO+NTYPE2(I)
TSN OFOR
                                                                                          00026700
TSN 0104
                    IF (BIAS2(I).EG.XBIAS) GO TO 220
                                                                                          00026750
ISN 010E
                    NBIAS#NBIAS+1
                                                                                          00888800
ISN 0107
                    NLC=2*NBIAS
                                                                                          00026650
ISN GICE
                    STOR1 (NLC-1) =BIAS2(I)
                                                                                          00026900
ISN 0109
                    STORI(NLC)=BEND2(I)
                                                                                          00026950
ISN 011C
                    BTYPE(1)=20+1
                                                                                          00027000
ISN 0111
               220 CONTINUE
                                                                                          00627650
ISN 0112
               230 CONTINUE
                                                                                          00027100
             C **** CHECK FOR INVALID INPUT
                                                                                          00027150
ISN 0113
                    IF (NCDF.GE.1.AND.NCOF.LE.4) GD TO 240
                                                                                          00027200
ISN 0115
                    IRET#3
                                                                                          00027250
ISN 0116
                    GO TO 780
                                                                                          00027300
               240 IF (NBIAS-LE-5) GO TO 250
ISN 0117
                                                                                          00027350
ISN 0115
                   IRET=4
                                                                                          00027400
ISN 0120
                    GD TO 780
                                                                                          00027450
ISN 0121
               250 CONTINUE
                                                                                          00027500
             C **** COMPUTE SOME CONSTANTS FOR THE SUMMATION
                                                                                          00027550
ISN 0122
                   N2=NCOF+NCOF
                                                                                          00927600
ISN 0123
                    N3=N2+NBIAS
                                                                                          00627650
ISN 0124
                    N4=N2+1
                                                                                          00027700
ISN 0125
                    N5=N3+1
                                                                                          00427750
```

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15N 0126
                     P= 181
                                                                                            00027800
ISN 0127
                     182=181+NB1A5-1
                                                                                            00627650
                     CALL PTSIZE FOR ARRYS TO BE DISPLAYED.
                                                                                            00027900
ISN 0128
                     CALL GTSIZE (GWORKO . IFLLO . IALLO . GWORKS . IFLLS . IALLS . GWORK4 . IFL 4 . IAO 0927950
                    11141
                                                                                            00028600
                     CALL PISIZE (NBIAS BTYPE)
                                                                                            00028050
                    CALL PTSIZE (NLC.STORI)
CALL PTSIZE (NLC.STORI)
CALL PTSIZE (20,ALPCUM,DELCUM,ARGCUM)
ISN 0130
                                                                                            00028100
ISN 0131
                                                                                            00028150
ISN 0132
                     CALL PISIZE (ACOF, ALP, DEL, ALPBND, DELBND)
                                                                                            00028200
ISN 0133
                     CALL PISIZE (NONE TIME , ANG , WGHT1)
                                                                                            00028250
TSN 0134
                     CALL PTSIZE (NTWO.TIME2, ANG2, WGHT2)
                                                                                            00028300
TSN 0135
                     NN3=1#NOME
                                                                                            00028350
ISN DIE
                     CALL PISIZE (NN3.AXIS1)
                                                                                            00028400
ISN 0137
                     NN6=6*NTWO
                                                                                            00028450
                     CALL PTSIZE (NN6.AXIS2)
ISN D138
                                                                                            00028500
ISN 0139
                     NP2=NP#NP
                                                                                            00028550
ISN 0140
                    CALL PISIZE (NP2.CDEF)
                                                                                            00038600
ISN 0141
                    CALL PISIZE (NCLASI.BIASI.BBND1)
                                                                                            00000660
                    CALL PISIZE (NCLAS2-81AS2-88NO2)
ISN 0142
                                                                                            00628700
ISN 0143
                260 INHERE=0
                                                                                            00028750
ISN 0144
                    IF (NCLASI.LE.O) GD TO 280
                                                                                            00628800
ISN 0146
                    DO 270 I=1.NCLAS1
                                                                                            00028650
                    J1=IFRST1(I)
ISN 0147
                                                                                            00028900
ISN 0148
                    N=NTYPE1(1)
                                                                                            00028550
15N 0149
                    1-M+1L=SL
                                                                                            00029000
15N 0150
                    DO 270 K=J1.J2
                                                                                            00629050
ISN 0151
                     WGHT1(K)=ABS(WGHT1(K))
                                                                                            00029100
ISN DIEZ
                270 CONTINUE
                                                                                            00620150
ISN 0153
                280 IF (NCLAS2.LE.0) GO TO 300
                                                                                            ADDREADA
                    00 290 1±1 NCLAS2
ISN 0155
                                                                                            00020280
ISN 0156
                    J1=IFRST2(I)
                                                                                            00029300
ISN 0157
                    N=NTYPE2(I)
                                                                                            00029350
ISN OF SE
                    12= 11+N=1
                                                                                            00029400
ISN ATEC
                    DG 290 K≒J1.J2
                                                                                            00029450
ISN 0160
                    WGHT2(K)=ABS(WGHT2(K))
                                                                                            00029500
                290 CONTINUE
ISN 0161
                                                                                            00029550
ISN 0162
                300 CONTINUE
                                                                                            00025600
                    DISPLAY ALL INPUT DATA AND CONTROL PARAMTERS AT *GCONEO*
                                                                                            00025650
ISN GLES
                                                                                            00020700
ISN 0164
                    CNC OF #NCDE
                                                                                            00029750
ISN 0165
                    ONCL51=NCLAS1
                                                                                            00029800
15N 0166
                    CNCL S2=NCL AS2
                                                                                            00029850
                    CALL CHECK (*GCDNEO*)
TSN 0167
                    IF (DNCOF.NE.NCOF.DR.ONCLS1.NE.NCLAS1.OR.ONCLS2.NE.NCLAS2) GD TO 100029950
ISN 0168
                   170
                                                                                            00030000
TSN 0170
                    NHS=0
                                                                                            00030050
ISN 0171
                    IF (NCLAS1.LE.O) GO TO 320
                                                                                            00030100
ISN 0173
                    DO 310 1=1.NCLAS1
                                                                                            00030150
ISN 0174
                    IF, (BIAS!(I).EQ.XBIAS) GO TO 310
                                                                                            00030200
ISN 0176
                    NBS=NBS+1
                                                                                            00030250
ISN 0177
                310 CONTINUE
                                                                                            00030300
ISN 0178
                320 IF (NCLAS2.LE.0) GO TO 340
                                                                                            00030350
ISN OLSC
                    CO 330 I=1.NCLAS2
                                                                                            00030400
                    IF (BIAS2(I).EQ.XBIAS) GO TO 330
ISN 0181
                                                                                            00030450
ISN 0183
                    NRS=NRS+1
                                                                                            00030500
                330 CONTINUE
TSN 01F4
                                                                                            00030550
TEN OIRS
                340 CONTINUE
                                                                                            00030600
ISN GREE
                    IF (NBS+2*NCCF.NE.ONP) GO TO 170
                                                                                            00030650
TSN 0188
                    IF (IOC.50.1) CALL PTSIZE (NONE, RHO1)
                                                                                            00030700
ISN CLOC
                    IF (ICALC.EQ.1) CALL PISIZE (NONE.CALCI)
                                                                                            00030750
ISN 0192
                    IF (IOC.EG.1) CALL PISIZE (NTWO.RHO2)
                                                                                            00030800
ISN 0154
                    IF (ICALC. EQ. 1) CALL PTSIZE (NTWG, CALC2)
                                                                                            00030850
                    IF (CERMIN-EC.1) CALL CHECK ( DCC11 )
ISN 0196
                                                                                            00030900
ISN 0198
                    IF, (CORMAX-EG-1) CALL CHECK ( DCC22 )
                                                                                            00030950
ISN 020C
                    CALL PISIZE (13, STORL)
                                                                                            00031000
               ***** INITIALIZE ITERATION COUNTER
                                                                                            00031050
ISN 0201
                    ISTER=0
                                                                                            00631100
                                                                                            00031150
              C **** BEGIN PROCESSING FOR THIS ITERATION
                                                                                            00631200
                                                                                            00031250
ISN 0202
                    DO 350 I=1.NCLAS1
                                                                                            00031300
ISN 0203
                350 ETASI(1)=BIAS1(1)
                                                                                            00031350
ISN 0204
                    00 360 I#1.NCLAS2
                                                                                            00031400
ISN 0205
                350 BIAS21(1)=81AS2(1)
                                                                                            00031450
                    00 370 I=1.NCCF
ISN 0206
                                                                                            00031500
ISN 0207
                    AI(I)=ALP(I)
                                                                                            00031550
ISN 0208
                370 DI(I)=DFL(I)
                                                                                            00031600
```

```
CO 380 I=1.4
                                                                                      00031650
ISN 0209
                    CLDALP(I)=0.
ISN 0210
                                                                                      00031700
                    GLDDEL(I)=0.
                                                                                      00031750
ISN 0211
                    CLDBS1(I)=0.
                                                                                      00031800
ISN 0212 -
                    aLDBS2{[]=0.
                                                                                      00031850
ISN 0213
                    NEWALP(I)=0.
                                                                                      00031900
ISN 0214
                    NEWDEL(I)=0.
                                                                                      00031950
ISN 0215
                   NEWBS1(I)=0.
15N 0216
                                                                                      00032000
                380 NEWBS2(I)=0.
ISN 0217
                                                                                      00032050
                    OLDBS1(5)=0.
ISN 0218
                                                                                      00632100
ISN 0215
                    GL0852(5)=0.
                                                                                      00032150
                    NEWBS1(5)=0.
ISN 0220
                                                                                      00032200
ISN 0221
                    NEWB52(5)=0.
                                                                                      00032250
ISN 0222
                390 CONTINUE
                                                                                      COFFEEDO
 ISN 0223
                    IG3=0
                                                                                      00032350
                    CALL MESAGE (**** THE SUBPROGRAM DCCONS $$$** IS NOW IN OPERATION 00032400
ISN 0224
                   1 * = * . 0 . 0 . 1 )
                    CALL PISIZE (NP.DRHOSG)
ISN 0225
                                                                                      00032500
                    ISTEP=ISTEP+1
                                                                                      00032550
ISN 022£
              C **** CONVERT ATTITUDE COEFFICIENTS TO RADIANS
                   DO 400 I=1.NCCF
                                                                                      00032650
ISN 0227
                    ALPR(1)=ALP(1)/RTOD
                                                                                      00032700
ISN 022E
                   DELR(I)=DEL(I)/RTOD
                                                                                      00032750
ISN 0229
                                                                                      00032800
                400 CONTINUE
ISN 0230
              C **** ZERO OUT MATRIX OF COEFFICIENTS
                                                                                      00032850
                   DO 420 1=1.N3
ISN 0231
                                                                                      00032900
                    00 410 J=1.N3
                                                                                      00032950
ISN 0232
                   COEF(J,I)=0.0
                                                                                      00033000
ISN 0233
ISN 0224
                410 CONTINUE
                                                                                      06033050
ISN 0235
                   DRHGSQ(I)=0.0
                                                                                      00433100
ISN 0236
                420 CONTINUE
                                                                                      00033150
ISN 0237
                    IBIAS=N2
                                                                                      00033200
                                                                                      00033250
              C **** BEGIN LOUP TO MAKE ALL SUMMATIONS FOR CLASS 1 CATA (CONE ANGLES)00032300
                                                                                      00033350
                    IF (NCLAS1.LE.0) GO TO 440
ISN 0238
                                                                                      00033400
                   ICALON. ##1 OEA DO
ISN 0240
              C **** ZERO OUT RESIDUAL SUMMATION VARIABLES
                                                                                      00633500
ISN 0241
                  RHOST1 (1.1)=0.0
                    AHOST1 (2.1)=0.0
                                                                                      00033600
ISN 0242
, ISN 0243
                    RHOST1(3,1)=0.0
                                                                                      00033650
ISN 0244
                    J1=IFRST1(I)
                                                                                      00033700
                    N=NTYPE!(I)
ISN 0245
                                                                                      00033750
ISN 0246
                    IF (N.LE.O) GG TO 430
                                                                                      00633800
                    IF (BIAST(I).NE.XBIAS) IBIAS=18IAS+1
ISN 0246
                                                                                      0.0033850
              C ***** CALL COFSUM TO COMPUTE AND SUM COEFFICIENTS FOR THIS TYPE OF
                                                                                      00033900
              C **** CLASS 1 DATA
                                                                                      60033950
                                                                                      00034000
ISN 0250
                    CALL COF5M (TIME1.AXIS1(1.J1).ANG1(J1).WGHT1(J1).N.1.3.ALPR.DELR.800034050
                   11AS1(I).(BIAS.COEF.DRHOSQ.RHOST1(1.I).RHO1.CALC1.SCOEF1.J1)
ISN 0251
                430 CONTINUE
 ISN 0252
                440 CONTINUE
              C ***** BEGIN LOOP TO MAKE ALL SUMMATIONS FOR CLASS 2 DATA (DHED ANGLES)00034350
                                                                                      00034400
 15N 0253
                    IF (NCLAS2-LE-0) GO TO 460
                                                                                      00034450
 ISN 0255
                   DO 450 I=1.NCLAS2
                                                                                      00034500
              C **** ZERO OUT RESIDUAL SUMMATION VARIABLES
                                                                                      00634550
 ISN 0256
                   RHOST2(1.1)=0.0
                                                                                      00034600
ISN 0257
                    RHOST2(2.1)=0.0
                                                                                      00034650
 ISN 0258
                    RH05T2(3.11=0.0
                                                                                      00034700
TSN 0255
                    J1=[FRST2(]]
                                                                                      00034750
ISN 0260
                    N=NTYPE2(I)
                                                                                      0.0034800
                                                                                      00034650
ISN 0261
                    IF (N.LE.O) GC TO 450
                    IF (BIAS2(1).NE.XBIAS) IBIAS=IBIAS+1
ISN 0263
                                                                                      00034900
              C ***** CALL COFSUN TO COMPUTE AND SUM COEFFICIENTS FOR THIS TYPE OF
              C **** CLASS 2 DATA
ISN 0265
                    CALL COFSM (TIME2.AXIS2(1.J1).ANG2(J1).WGHT2(J1).N.2.6.ALPR.DELR.B00035100
                   11AS2(I).IBIAS.COEF.DRHOSQ.RHOST2(1.I).RHO2.CALC2.SCOEF2.J1)
                                                                                      00935150
              ISN 0266
                450 CONTINUE
                                                                                      00035250
                                                                                      COESEDOO
 ISN 0267
                460 CONTINUE
                                                                                      00035350
              C **** COFSUM COMPUTES ONLY DIAGONAL AND UPPER RIGHT OFF-DIAGONAL
              C ***** FLEMENTS OF THE COEFFICIENT MATRIX BECAUSE IT IS A SYMMETRIC
                                                                                      00035400
              C **** MATRIX
                                                                                      00035450
```

```
C **** COMPLETE LOWER LEFT OFF-DIAGONAL ELEMENTS OF SYMMETRIC MATRIX
                                                                                     00035500
                                                                                     00035550
                  FOR PRINTED OUTPUT AND DISPLAY PURPOSES.
                                                                                     00035600
ISN 0266
                   BUSSE OZY DU
                                                                                     0.0035650
ISN 0269
                   N = T - 1
                                                                                     00035700
ISN 0270
                  DD 470 J#1.N
                                                                                     00035750
ISN 0271
                   COEF([,J)=COEF(J.[)
                                                                                     00935800
ISN 0272
               470 CONTINUE
                                                                                     00035850
ISN 0273
                  IF (IWRT-LT-10) GD TO 490
             C **** WRITE COEFFICIENTS OF SIMULTANEOUS EQUATIONS
                                                                                     00035950
                  MRITE (IDUT. 990)
ISN 0275
                                                                                     00436000
                  DO 480 I=1.N3
ISN 0276
                                                                                     00036650
                  WRITE (IDUT. 1000) (CCEF(1,J), J=1.N3) .DRHCSQ(1)
15N 0277
                                                                                     00036100
               ARD CONTINUE
TON 0278
                                                                                     00036150
               AGG CONTINUE
15N 0276
             C **** CALL IBM SSP ROUTINE MINV TO INVERT COEF MATRIX
                                                                                     00036200
             INMERES!
ISN 0280
                  DISPLAY COEFFICIENT MATRIX.
                                                                                    ----
             00036450
                   CALL SYMMETRIC MATRIX INVESTER.
                                                                                     00036500
                  CALL BLKING (COEF.1.N3.NP.CET. IERR, STOR1.STOR2.RL)
ISN 0281
                                                                                     00036550
                   1F (DET.NE.0.0) GD TO 500
15N 0282
                                                                                     COBRECCO
                   IRET=5
TSN 0284
                   60 TO 780
                                                                                     00036660
ISN 0285
                                                                                     COLATAGO
               SOO CONTINUE
TSN 028E
             C **** MULTIPLY MATRIX INVERSE (COVARIANCE MATRIX) BY VECTOR OF RHO
                                                                                     00036750
             C **** SQUARED DEPIVATIVES TO DETAIN ATTITUDE STATE CORRECTIONS
                                                                                     00036600
                                                                                     00436850
ISN 0287
                   DO 510 IEL-NE
                                                                                      00236900
                   CHNG(I)=0.0
ISN 0288
                                                                                      00036950
                   DO 510 J=1.N3
ISN 0289
                   CHNG(I)=CHNG(I)+COEF(I.J)*DRHOSQ(J)
                                                                                      00037000
ISN 0290
                                                                                     00037050
               510 CONTINUE
15N 0291
                   USE STORE AND STORE FOR MSAD DISPLAYS.
                                                                                     00637100
                                                                                     00037150
                   DO 520 I#1.13
TEN DOGS
                                                                                      00077200
                   STOR1(1)=0.
15N 0293
                                                                                      00037250
               520 STOR2(I)=0.
TSN 0254
                                                                                     COETECOS
                   nn 530 1≒1.NCCF
ISN 0295
                                                                                      OPETEROO
                   STOR1 (341-1)=CHNG(2+1-1)
TON 0296
                                                                                     00037400
               530 STOR1(3*[)=CHNG(2*1)
ISN 0297
                                                                                      00037450
                   00 540 I=1 NEIAS
ISN C298
                                                                                      00037500
               540 STUR1(3*1-2)=CHNG(2*NCOF+1)
TSN 0299
                   NSTOR1=2*NCOF+MAKO(NCOF+NB1AS)+1
                                                                                      00037550
ISN 0300
                                                                                      0037600
                   CALL PISIZE (NSTOR1.STOR1)
ISN 0301
                                                                                     .00037650
                   IF (1STOP.NE.0) GO TO 500
15N 0302
                                                                                      00037700
             C **** SET INDICATOR TO *CONVERGED*
                                                                                      00037750
                   IRFT=0
TSN 0304
                                                                                      00037800
                   DO 550 I≃1.NCCF
ISN 0305
             C **** CHECK FOR NEN-CONVERGENCE
                                                                                      00037850
                   IF (ABS(CHNG(2*I-1)).GT.ALPBND(1)) IRET=1
                                                                                      00037900
TCN 0306
                   IF (ABS(CHNG(2*1)).GT.DELBND(1)) IRET=1
                                                                                     00037650
15N 0308
                                                                                      00038000
             C **** CHECK FOR DIVERGENCE
                   IF (ABS(CHNG(2*1-1)).LE.360.0.DR.ABS(CHNG(2*1)).LE.360.0) GO TO 5500038050
ISN 0310
                  10
                   IRET=2
ISN OF12
                                                                                      00638200
                   GO TO 780
ISN 0313
                                                                                      00038250
               550 CONTINU€
15N 0314
             C **** CHECK FOR DIVERGENCE OR CONVERGENCE OF BIAS ELEMENTS
                                                                                      ODEBEDDO
                                                                                      00038350
                   IF (NBIAS-LE-O) GO TO 590
ISN 0315
                                                                                      00038400
                   K≂N2
ISN 0317
                                                                                      00038450
                   IF (NCLAS1.LE.0) GD TO 570
15N 031E
                                                                                      00638500
                   DO 560 I=1.NCLAS1
15N 0320
                   IF (BIAS1(1).EQ.XBIAS) 60 TO 560
                                                                                      00036550
ISN 0321
                                                                                      00038600
                   K=K+1
ISN 0723
                   IF (ABS(CHNG(K)).GT.BBND1(I)) IRET=1
                                                                                      00038650
15N 0324
                                                                                      00038700
                   IF (ABS(CHNG(K)).LE.360.) GO TO 560
15N 0326
                                                                                      00038750
                   IRET#2
TSN 0328
                                                                                      CORREGOO
                   GD TO 780
ISN 0329
ISN 0330
               560 CONTINUE
                                                                                      00038850
               570 CONTINUE
                                                                                      OCCUBAÇÃO O
15N 0331
                   IF (NCLAS2.LE.O) GO TO 590
                                                                                      00038950
ISN 0332
                   DO 580 1=1 NCLAS2
                                                                                      00039000
ISN 0234
                   IF (BIAS2(I).EQ.XBIAS) GO TO 580
                                                                                      00039050
SEED NEI
                                                                                      00039100
15N 0337
                   K=K+1
                                                                                      00039150
                   IF (ABS(CHNG(K)).GT.BBND2(1)) IRET=1
SEED NRI
                                                                                      00639200
                   IF (A8S(CHNG(K)).LE.360.) GD TC 580
15N 0340
                   IRET=2
                                                                                      00039250
ISN 0342
                                                                                      00439300
                   GD 10 780
ISN 0343
```

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ISN 0344
                580 CONTINUE
                                                                                         00039350
                590 CONTINUE
ISN 0345
                                                                                          00039400
15N 0346
                600 CONTINUE
                                                                                          00039450
ISN 0347
                    TPRNT=1
                                                                                          00039500
                    IF (IWRT.LT.4) IPRNT=0
ISN 0348
                                                                                          00039550
                    IF(IPRNT.EQ.O.AND.ISTAT.NE.1) GC TO 650
              c
                    COMPUTE THE COVARIANCE/CORRELATION MATRIX.
                                                                                          00039650
15N 0350
                    NBB=NB-1
                                                                                          00035700
15N 0351
                    00 610 f=1.N33
                                                                                          00039750
ISN 0352
                    11 = 1 + 1
                                                                                         00039800
ISN 0353
                    DO 610 J=II.N3
                                                                                         00039850
                610 COEF(J,I)=COEF(J,I)/SQRT(ABS(COSF(I,I)*COEF(J,J)))
ISN 0354
                                                                                         00035900
ISN 0355
                    DO 620 I=1,39
                                                                                         00039950
ISN 0356
                620 WORK(I)=0.
                                                                                         00040000
              c
                    STORE DATA FOR MSAD DISPLAYS IN ARRAYS STYPE AND WORK.
                                                                                         00040050
                                                                                         00040100
              C ***** COMPUTE AND PRINTOUT STATISTICS OF RESIDUALS
                                                                                          00040150
                                                                                          00040200
              C **** STATISTICS FOR CLASS 1 TYPES
                                                                                          00040250
ISN 0357
                    aT1=0.0
                                                                                         00040300
ISN 0358
                    STA1=0.0
                                                                                          00040350
ISN 0259
                    STB1=0.0
                                                                                          00640400
                    IF (NCLAS1.LE.O) GO TO 640
ISN 0360
                                                                                          00040450
ISN 0362
                    NUM=NCLAS1+NCLAS2+3
                                                                                          00040500
ISN 0363
                    CALL PISIZE (NUM, STYPEZ)
                                                                                          00040550
ISN 0364
                    N UM=3≉NUM
                                                                                          00640600
ISN 0365
                    CALL PISIZE (NUM. WORK)
                                                                                          00040650
ISN 0366
                   90 630 I=1+NCLAS1
                                                                                         00040700
ISN 0367
                    STYPE1(I)=ANUM(1)
                                                                                         00040750
ISN 0368
                    STYPE2(I) #ANUM(I)
                                                                                         00040800
ISN 0369
                    % =RHOST1(3,1)
                                                                                         00040650
ISN 0370
                    IF (w.LE.0.0) GO TO 630
                                                                                         00040500
ISN 0372
                    S1=RHOST1(1.1)/W
                                                                                         00040950
ISN 0272
                    S2=SQRT(AMAX1(RHOST&(2.1)/W-S1*S1.0.1)
                                                                                         00041000
ISN 0374
                    RHGT1(4.1)=51
                                                                                         00041050
ISN 0375
                    RHOT1 (5.1)=S2
                                                                                         00041100
ISN 0376
                    WORK (341-2)=51
                                                                                         00041150
ISN 0377
                    WORK (3#I-1) = $2
                                                                                         00041200
ISN 0378
                    WORK(3*I)=W
                                                                                         00041250
ISN 0375
                    WT1=WT1+W
                                                                                         00641300
ISN 0360
                    STA1=STA1+RHCST1(1,1)
                                                                                         00041350
19N 038%
                    STB1=STB1+RHGST1(2,1)
                                                                                          00041400
ISN 0382
                630 CONTINUE
                                                                                          00041450
                    IF (WT1.LE.0.0) GO TO 640
ISN 0383
                                                                                         00641500
ISN 0365
                    S1=STA1/WT1
                                                                                         00041550
ISN 0386
                    S2=SCRT(AMAX1(STB1/WT1-S1*S1.0.))
                                                                                         00041600
1SN 0367
                    WORK(3*NCLA51+1)=51
                                                                                         00041650
38E0 N21
                    BORK(3*NCLAS1+2)=52
                                                                                         00041700
ISN 0385
                    WORK(3*NCLAS1+3)=WT1
                                                                                         00041750
ISN 0390
                    STYPE1(NCLAS1+1)=ANUM(1)
                                                                                         0081800
ISN 0391
                    STYPE2(NCLAS1+1)=TOTAL
                                                                                         00041850
ISN 0392
                640 CONTINUE
                                                                                         00041900
             C **** STATISTICS FOR CLASS 2 TYPES
                                                                                          00041950
ISN 0393
                    WT2=0.0
                                                                                         00042000
ISN 0394
                    STA2=0.0
                                                                                         00042050
TSN 0395
                    ST82≃0.0
                                                                                         00042100
ISN 0396
                    IF (NCLAS2.LE.O) GC TO 660
                                                                                          00042150
ISN 0398
                    DO 650 I=1,NCLAS2
                                                                                          00042200
ISN 0399
                    STYPE1(NCLAS1+1+1)=ANUM(2)
                                                                                          00042250
ISN 040C
                    STYPER(NCLAS1+1+1) #ANUM(I)
                                                                                         00042300
                    w=RH0ST2(3,1)
ISN 0401
                                                                                         00042350
15N 0402
                    IF (W.LE.O.O) GO TO 650
                                                                                         00042400
ISN 0404
                    $1=RHOST2(1,1)/W
                                                                                         00042450
ISN 0405
                    $2=$QRT(AMAX1(RHGST2(2.1)/W-51*$1.0.))
                                                                                         00042500
ISN 0406
                    RHOT2(4.1)=51
                                                                                         00042550
ISN 0467
                    SHOT2 (5.1) = 52
                                                                                         00042600
ISN 0408
                    WDRK(3*(NCLAS1+1+1)-2)=S1
                                                                                         00042650
ISN 0409
                    WORK (3*(NCLAS1+1+1)-1)=S2
                                                                                         00042700
ISN 0410
                    #GRK(3#(NCLAS1+1+1))=W
                                                                                         00042750
ISN 0411
                    %T2=%T2+W
                                                                                         00042800
ISN 0412
                    STA2=STA2+RHCST2(1.1)
                                                                                         00042850
ISN 0017
                    STB2=STB2+RHCST2(2.1)
                                                                                         00042900
ISN 0414
               650 CONTINUE
                                                                                         00042950
ISN 0415
                    IF (%T2.LE.0.0) GD TO 660
                                                                                         00043000
ISN 0417
                    S1=STA2/WT2
                                                                                         00043050
ISN 0418
                    52=SCRT(AMAX1(STB2/WT2-51*S1.0.))
                                                                                         00643100
ISN 0419
                    WORK(3*(NCLAS1+NCLAS2)+4)=S1
                                                                                         00043150
```

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MORK (3% (NC) AS1+NC) AS2)+51=S2
                                                                                            00043200
TEN DAGE
                    WORK (3*(NCLASI+NCLASE)+6)=WT2
                                                                                            00043250
TEN 0421
                660 CONTINUE
                                                                                            00043300
ISM 0422
                    STYPE1 (NCLAS1+NCLAS2+2) = ANUM(2)
                                                                                            00043350
ISN 0423
                    STYPE2(NCLAS1+NCLAS2+21=TOTAL
                                                                                            00043400
TSN DASA
              C **** COMBINED TOTAL STATISTICS
                                                                                            00043450
                                                                                            00643500
                    STYPES (NCLASIANCLASSAS)=TOTAL
ISN 0425
                    STYPE2(NCLAS1+NCLAS2+3)=STAT2
                                                                                            00043550
I5N 0426
                    IF (#T2.LE.O..OR. #T2.LE.O.) GO TO 670
ISN 0427
                                                                                            00043600
                    W=WT!+WT2
                                                                                            00043650
ISN GAZG
                    S1=(STA1+STA2)/W
                                                                                            00043700
ISN 0430
                     S2=SQRT(AMAX1((STB1+STB2)/W-S1*S1.0.))
                                                                                            00043750
ISN 0431
                    *ORK(3*(NCLA51+NCLAS2)+7)=$1
                                                                                            00643800
ISN 0432
                                                                                            00043850
ISN 0473
                    MODE (3# (NCLAS1+NCLAS2)+R)=S2
                                                                                            00643900
                    MORK (3# (NCLA51+NCLA52)+9)=W
ISM DATA
                670 IF (IPRNT.EQ.0) GO TO 710
                                                                                            00943950
TEN DAZE
                                                                                            00044000
              C **** WRITE COVARIANCE ELEMENTS
                    IF (NBIAS.E.Q) WRITE (10UT.1060) (NAME(1.1).NAME(2.1).1=1.N2) 00044050
IF (NBIAS.GT.0) WRITE (10UT.1060) (NAME(1.1).NAME(2.1).1=1.N2).(NA00044100
ISN 0437
ISN 0439
                   1ME(1.1).NAME(2.1).1=161.1B2)
                                                                                            00044150
                                                                                            00044200
                    EN. 1 = 1 096 00
ISN na41
                                                                                            00044250
TSN 0442
                    # T = T
                                                                                            00644300
                    IE (1-GT-N2) II=1-N2+8
ISN DAA?
                680 WRITE (1001,1070) NAME(1,11), NAME(2,11), (COEF(1,J),J=1,N3)
                                                                                            00044350
ESN DAAR
                                                                                            00084400
TON DAAS
                    IF (NCLAS1.LE.O) GO TO 690
ISN G44E
                     WRITE (IDUT, 1080)
                                                                                            00044450
                     *RITE (IQUT, 1100) (I, WORK(3*1-2), WORK(3*1-1), WORK(3*1), I=1, NCLAS1)00044500
ISN 0449
                     WRITE (IOUT,1980) WORK(3*NCLAS!+1),WORK(3*NCLAS!+2),WORK(3*NCLAS!+00D44550
ISN 0450
                                                                                            00044600
                                                                                            00044450
                690 IF (NCLAS2.LE.O) GO TO 700
ISN 0451
                                                                                            00044700
ISN 0453
                    WRITE (10UT.1090)
                    hRITE (IOUT, $300) (1, WORK(3*NCLAS1+1+3*1), WURK(3*NCLAS1+2+3*1), WOR00044750
ISN 0454
                   1K(3*NCLAS1+3+3*[], I=1, NCLAS2)
                    WRITE (IOUT. 1110) WCFK(3*(NCLAS1+NCLAS2)+4).WOFK(3*(NCLAS1+NCLAS2)00044650
TEN DASE
                                                                                            00044900
                   1+5), #ORK(3*(NCLAS1+NCLAS2)+6)
                    WRITE (IBUT, 1120) WORK (3*(NCLAS1+NCLAS2)+7) . WORK (3*(NCLAS1+NCLAS2
                                                                                           100044550
ISN 0456
                                                                                            00045000
                   1 + 81
                                                                                            00045050
ISN 0457
                700 CONTINUE
                                                                                            00045100
ISN 045 E
                710 CONTINUE
                                                                                            00045150
ISN 0459
                    INHERE=2
                    CALL CHECK ( GCONE 2 )
                                                                                            00046200
ISN 0460
              C **** IF PROCESS HAS ENDED JUMP OUT OF CORRECTION LOOP
                                                                                            00045250
              C **** UPDATE ATTITUDE STATE
                                                                                            00045300
                    DG 720 I=1.13
                                                                                            00045350
ISN 0461
                720 STOR2(1)=0.
                                                                                            CCC45400
ISN 0462
                    NB=3*NCOF+NBIAS
                                                                                            00045450
ISN 0463
                                                                                            00045500
                    (EL.BN)ONIM=HA
TEN DAFA
                    CALL PTSIZE (NO.STORZ)
                                                                                            00045550
ISN 0465
                                                                                            00045600
                    00 730 I=1.NCCF
TSN 0466
                                                                                            00045650
ISN 0467
                     STOR2(2*[-1]=ALP(I)
                                                                                            00045700
ISN 046E
                730 STOR2(2*1)=DEL(I)
                                                                                            00.045750
                    00 740 I=1,NCCF
TSN 0469
                                                                                            00045800
ISN 0470
                    OLDALP(I)=ALP(I)
ISN 0471
                     CLDDEL(I)=DEL(I)
                                                                                            00045650
                     ALP(I)=ALP(I)+CHNG(2*1-1)
                                                                                            00045900
ISN 0472
                                                                                            00045950
TEN DATE
                    DEL(I)=DEL(I)+CHNG(2*I)
                                                                                            00046000
ISN 0474
                    NÉWDEL(I)=DEL(I)
                    NEWALP(T)=ALF(I)
                                                                                             00046050
ISN 0475
                                                                                            00046100
ISN .047E
                ZAO CONTINUE
                     IF (NBIAS-LE-0) GO TO 780
                                                                                            00046150
ISN 0477
                                                                                             00046200
ISN 0479
                     K≃N2
                     IF (NCLAS1.LE.O) GO TO 760
                                                                                             00046250
TSN 0480
                                                                                             00046300
                     CALL PISIZE (NBIAS.DRHOSQ)
TSN 0482
15N 0483
                     DO 750 I±1.NCLAS1
                                                                                             00046350
                     IF (81AS1(I).EQ.XBIAS) GU TO 750
                                                                                             00646400
ISN GARA
                                                                                             00046450
                     K = K + 1
TSN 0486
                                                                                             00046500
                     STOR2(K)=BIAS1(I)
15N 04E7
                     OLD851(I)=BIAS1(I)
                                                                                             00046550
15N 0486
                     BIAS1(1)=BIAS1(1)+CHNG(K)
                                                                                             00646600
TSN 0489
                                                                                             00046650
ISN 0490
                     NEWRST(I)=BIAS1(I)
                                                                                             00046700
ISN 0491
                    DRHOSO(K)=BLASI(I)
                                                                                             00046750
ISN 0492
                750 CONTINUE
                                                                                             00046600
ISN 0493
                760 CONTINUE
TSN 0494
                     IF (NCLAS2.LE.O) GO TO 780
                                                                                             00046650
                    DG 770 1=1.NCLAS2
                                                                                             00046900
15N 045E
                    IF (BIAS2(I).FG.XBIAS) GO TO 770
                                                                                             00046550
ISN 0457
                                                                                             00047000
ISN 0495
                    K=K+1
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00047050
                   STOR2(K)=BIAS2(I)
ISN GSGC
                                                                                       00647100
                   DLDBS2(I)=BIAS2(I)
ISN 0501
                                                                                       00047150
                   @IAS2(1)=81AS2(1)+CHNG(K)
15N 0502
                                                                                       00647200
                   NEWBS2(I)=BIAS2(I)
ISN 0502
                                                                                        00047250
                   DRHOSQ(K)=BIASS(I)
ISN OFO4
                                                                                       00647306
               770 CONTINUE
TSN GFOF
                                                                                        00447350
               780 CONTINUE
ISN 0506
                                                                                        00047400
                   IF (IRWT.LT.6) GO TO 840
ISN 0507
                                                                                        00047450
             C **** WRITE UPDATED ATTITUDE STATE
                                                                                        00047500
                  WRITE (10UF.1010) ISTEP
ISN 0505
                                                                                        00047550
                   DO 790 I=1.NCCF
ISN 0510
                                                                                        00047600
ISN 0511
                   Ani D=ALP(I)-CHNG(2*I-1)
                                                                                       00047650
                   DOLD=DEL(1)=CHNG(2*1)
ISN 0512
                   wPITE (IGUT.1020) ADLD.CHNG(2*I-1).ALP(I).DOLD,CHNG(2*I).DEL(I)
                                                                                        00047700
ISN 0512
                                                                                        00047750
               790 CONTINUE
15N 0514
                                                                                        00047800
                   IF (NBIAS.LE.O) GO TO 830
ISN 0515
                                                                                        00047850
                   K=N2
ISN 0517
                                                                                        00047900
                   IF (NCLAS1.LE.0) GO TO 810
ISN 051E
                                                                                        00047950
                   ITITLE=1
ISN 0520
                                                                                        00048000
                   00 800 I=1,NCLA51
ISN 0521
                                                                                        00048050
                   IF (EIAS1(1).EG. XBIAS) GO TO 800
ISN 0522
                                                                                        00048100
                   K≠K+1
TSN 0524
                                                                                        00048150
                   BOLD=BIASI(I)-CHNG(K)
ISN 0525
                                                                                        00048200
                    IF (ITITLE.EC.1) WRITE (IOUT,1030)
ISN 0526
                                                                                        00048250
                   ITITLE=2
ISM 052F
                                                                                        00048300
                    WRITE (IOUT.1050) I.BOLD.CHNG(K).BIAS1(I)
ISN 0529
                                                                                        00048350
               800 CONTINUE
ISN 0530
                                                                                        00648400
ISN 0531
               810 CONTINUE
                                                                                        00048450
                   IF (NCLAS2.LE.O) GO TO 830
15N 0532
                                                                                        00048500
                   ITITLE=1
ISN 0534
                                                                                        00048550
                   DG 820 I=1.NCLAS2
ISN 0535
                                                                                        00048600
                   IF (BIAS2(I).EC.XBIAS) GO TO 820
ISN 0526
                                                                                        00048650
ISN 0538
                   K=K+1
                                                                                        00048700
                    eqLD=BIAS2(I)-CHNG(K)
ISN 0539
                                                                                        00048750
                    IF (ITITLE.EG.1) WRITE (10UT.1040)
ISN 0540
                                                                                        00888000
                    ITITLE=2
ISN 0542
                    WRITE (IDUT.1050) I.BOLO.CHNG(K).BIAS2(I)
                                                                                        00048850
E430 N21
                                                                                        00048900
                BZO CONTINUE
ISN 0544
                                                                                        00048950
               830 CONTINUE
ISN OSAE
                                                                                        00040000
               840 CONTINUE
ISN 0546
                                                                                        00049050
                   DO 850 II=1.10
ISN 0547
                                                                                        00049100
                850 CPTION(11)=0
ISN 0546
                                                                                        00049150
                   FINALD=0
ISN GEAS
                                                                                        00449200
ISN 0550
                    FINISH = 0
                                                                                        00049250
                   DD 860 II=1.8
ISN 0551
                                                                                        00049300
               860 IMESG(II)=0
ISN 0552
                   IF (IREThEQ.0) IMESG(1)=1
IF (IREThEQ.2) IMESG(2)=1
ISN 0553
                                                                                        00049400
ISN 0555
                                                                                        00049450
                    IF (ISTEP.NE.MAXIT) GO TO 870
ISN 0557
                                                                                        00049500
ISN 0559
                    IMFSG(3)=1
                                                                                        00049550
ISN 0560
                    IDET=6
                                                                                        00049600
ISN 0561
                870 CONTINUE
                    IF (IRETSEG-3) IMESG(4)=1
                                                                                        00049650
ISN 0562
                                                                                        00046700
                    IF (IRET-EQ.4) IMESG(5)=1
15N 0564
                                                                                        00049750
                    IF (IRET+EQ+5) IMESG(6)=1
ISN 0566
                    CALL GTSTAT (*OPTABL*.STATE)
ISN 0568
                                                                                        00049650
                    IF (STATI.NE.STOP1.CR.[OPEN.EQ.O) GO TO 880
ISN 0569
                    IF (IALLO.EQ.224) CALL FINALZ (GWORKO.ALP.DEL,AI,DI.BIASI.BIAS1.BIO0049900
ISN 0571
                                                                                        00049950
                   1AS21.81AS2.RHCT1.RHOT2.NCLAS1.NCLAS2.NCOF.IALLO.CDEF.NP)
                                                                                        00050600
                    CALL CHECK ( *CPTAB! )
ISN 0573
                    CALL GOCCON (IALL4.IALL5.IFRST1.IFRST2.NTYPE1.NTYPE2.RHG1.RHG2.GWGGGGGGGG
ISN 0574
                                                                                        00050100
                   1RK4 - GWORK5 - IALLO)
                                                                                        00050150
ISN 0575
                SEC CONTINUE
                    IF (IMESG(8).EG.1.OR.(STAT1.NE.STOP1.AND.IRET.NE.1)) RETURN
                                                                                        00050200
ISN 0576
                                                                                        00050250
                    IF (IMESG(7).E0.1) GO TO 260
ISN 0576
                                                                                        00050300
                    IF (IRETANE-1) RETURN
ISN 05EC
                                                                                        00050350
ISN 0582
                    GO TO 390
                                                                                        00050400
              00050500
                890 FORMAT (1X,20(***), DCCONS - V 2.0 - CREATED 7/23/73*,20(***))
                                                                                        00050550
ISN 0583
                900 FORMAT (1x.//1x.45("-"), *SPECIFIED GUTPUT FROM SUBROUTINE DCCOMS *00050600 1.45("-"), *NCLAS1 NCLAS2 TZERO NCGF MAXIT IMR00050650
ISN 0584
                                                                                        00050700
                   27 10UT*./.1X.218.F12.4.418)
                910 FORMAT (1x./.1x. INITIAL ATTITUDE COEFFICIENTS AND CORRECTION BOUND0050750
ISN 0565
                                  ALPHA(DEG) CORR BND(DEG) DELTA(DEG) CORR BND00050800
                   1DS *./,1X.*
                                                                                        00050650
                   2(DEG)**/*(1x*F14*4*F16*6*F14*4*F16*6))
```

```
15N 0586
               920 FORMAT (1x./.1x, CLASS 1 (CONE ANGLE) INITIAL BIASES ./.1x. TYPE 00050900
                      BIAS(DEG) CORR BND (DEG) )
                                                                                     00050550
               ISN OSEZ
                      BIAS(DEG) CORR BND(DEG)*)
                                                                                     00051050
               940 FCRMAT (1X.14.F15.4.F16.4)
ISN 0588
               950 FORMAT (1x,/.1x, CLASS 1 (CONE ANGLE) INPUT DATA TYPE, 12, HAS 100051150
ISN 0585
                 14. CHSERVATIONS, FROM', 14. TO', 14. IN THE DATA ARRAYS')
                                                                                     0005120n
               960 FORMAT (1x./.1x.*CLASS 2 (DHED ANGLE) INPUT DATA TYPE*.IZ.* HAS*.100051250
ISN OSCC
               14. CBSERVATIONS, FROM: 14.* TO:,14.* IN THE DATA ARRAYS')
970 FORMAT (1X./-1X.* 1 TIME X-AXIS Y-AXIS
                                                                                   . 00051300
                                                                                  7-400051350
ISN 0591
                                     1 :
                                         WEIGHT ./.(1x.14.F16.6.2x.3F10.6.F14.4.F12.00051400
                  4 4 7 6
                          CONF ANGLE
                  2411
                                                                                     00051450
ISN 0592
               980 FORMAT (1x./.1x.*
                                     T
                                                    TIME
                                                           X-AXIS-1 Y-AXIS-1 Z-AXIGOGS1500
                        X-AXIS-2 Y-AXIS-2 Z-AXIS-2 DHED ANGLE WEIGHT ./. (00051550
                  21X.I4.F16.6.2X.3F10.6.2X,3F10.6.F14.4,F12.4))
                                                                                     00051600
ISN 0593
               990 FORMAT (1x.//,1x. SIMULTANEOUS ATTITUDE EQUATIONS CGEFFICIENTS"./.00051650
                 12X)
                                                                                     00051700
TON COGA
              1000 FORMAT (1x.10F13.6)
                                                                                     00051750
             1010 FORMAT (1x,//.1x, ITERATION'.13, - ATTITUDE AND BIAS STATE 1.//.100051800
15N 0505
                 1x, OLD ALPHA(DEG)
                                           CHANGE(DEG) NEW ALPHA(DEG)
                                                                                OLD D00051650
                  2FLTA (DEG)
                                CHANGE (DEG)
                                              NEW DELTA(DEG)
ISN 0596
              1020 FDRMAT (1X.3F17.8.4X.3F17.8)
                                                                                     00051650
ISN 0597
              1030 FORMAT (1x./.1x, CLASS 1 (CONE ANGLE) BIAS STATE .... TYPE
                                                                                   OL00052000
                  ID-BIAS(DEG) CHANGE(DEG) NEW BIAS(DEG)*)
                                                                                     00052050
              1040 FORMAT (1x./.1x. CLASS 2 (DHED ANGLE) BIAS STATE "./.ix. TYPE
ISN 0598
                                                                                   01.00652100
                 10 SIAS(DEG)
                               CHANGE (DEG) NEW BIAS (DEG) )
                                                                                     00052150
             1050 FORMAT (1x,14,F16.6,F14.6,F16.6)
ISN 0599
                                                                                     00052200
             1060 FORMAT (1x. -1x. ATTITUDE STATE COVARIANCE/CORRELATION MATRIX . /,00052250
TSN 0600
                 11x.10X.13(1x.2A4))
                                                                                     00052300
             1070 FORMAT (1x,2A4,2x,13E9,2)
TSN 0601
                                                                                     :00052350
             1080 FORMAT (1x./.18x. CLASS 1 (CONE ANGLE) ERROR STATISTICS ..... 100052400
ISN 0602
                                               STANCARD DEVIATION (DEG)
                 1 YPF
                         MEAN RESIDUAL (DEG)
                                                                             TOTAL 00052450
                 2WEIGHT*)
                                                                                     00652500
             1090 FORMAT (1X./.18X.*CLASS 2 (DHED ANGLE) ERROR STATISTICS *./.1X.* T00052550
ISN 0603
                 1 YPF
                       MEAN RESIDUAL (DEG)
                                               STANCARD DEVIATION (DEG)
                                                                              TOTAL 00052500
                  2 WEIGHT*)
             1100 FORMAT (1x.15.4x.F13.4.5x.4x.F18.4.5x.8x.F12.4)
                                                                                     00052700
15N 0508
             1110 FORMAT (1X.*ICTAL*.4X.F13.4.5X.4X.F18.4.5X.8X.F12.4) 0.0052750
1120 FORMAT (1X.*.COMBINED TOTAL MEAN RESIDUAL(DEG) = ".F9.4." 0.0052800
TEN DECE
15N 0506
                       STANDARD DEVIATION(DEG) = 1.F9.4)
TEN CACT
```

COMPILER GPTIONS - NAME: MAIN.OPT=01,LINECNT=60.SIZE=0000K, SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NDECIT,10,XREF

| • | SOUR | CE.EBCDIC. | NOLIST, NGD | ECK, LOAD, MAP, NOEDIT, ID, XREF | |
|----------|---|-------------------|--------------------|---|------------------------|
| C | | | | | 00000050 |
| C | *********** | 当会的证券企业务金融 | 斯格迪拉斯松达 拉拉沙 | 经经验的证证证券 电电影的非常等的 医神经炎性 医神经炎性 化二甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基 | ************** |
| Č | | | | | *00000200 |
| č | SLURGUTIN | E COFSM | | | *C0000250 |
| ċ | | | | | *00600300 |
| C | CALLING S | EGUENCE | | | *00000350 |
| C | | CALL COFS | | S,ANG,WGHT,NUMB,ITYPE,NDIM, | *00000400 |
| Ç | | | | R.BIAS.IBIAS.COEF.CRHGSG.RHOST. | *00400450 |
| Č. | | | RH, CALC | SCORF, JONE) | *00CC0500 |
| Ċ C | DESCRIPTI | r.k | | | *00000550 *00000600 |
| č | DE OCKET II | | SIMILAR TO | THE GCONES ROUTINE COFSUM WITH | *00000650 |
| č | | | WING ADDED | | *C0000700 |
| Ċ. | | CAN BE ST | ORED. DERI | VATIVES CAN BE STORED. AND | *00000750 |
| С | | RESIDUALS | CAN BE ST | ORED. | 00800000 |
| C | | | | | *00000E50 |
| <u> </u> | CEMMON AR | EAS REFERE | NCED | | *00600900 |
| Ç | | GNC1 | | | *00000550 |
| C C | | GNCI | | | *00001000 |
| č | EXTERNAL | REFERENCES | | | *00C01100 |
| č | • | | | | *00601150 |
| c | | ABS.COS.S | IN | | *00601200 |
| C | | | | | *00001250 |
| Ç. | STORAGE R | EQUIREMENT: | S | | +00601300 |
| c | | | | | *00001350 |
| c | | 4884 BYIE | S OF CORE | STURAGE | *00001400 |
| C C | VARIABLES | | | • | *00001450 *00601500 |
| č | *************************************** | | | | #00001550 |
| č | NAME | TYPE | 1/0 | DESCRIPTION | *00001600 |
| c | | | | | *00001650 |
| τ | TIME | 尺本 4 | I | ARRAY OF OBSERVATION TIMES | *60001700 |
| c | | | | | *00001750 |
| Ç | AXIS | R*4 | 1 | REFERENCE VECTORS(DIMENSIONED | *00¢C1800 |
| C C | | | | NDIM#(NUMBER OF OBSERVATIONS)) | *00001850 |
| c | ANG | R*4 | r | OBSERVED ANGLES, IN DEGREES | *00001900 |
| č | | | - | ODDERVED ARRECTY IN DEGREES | *00002000 |
| c | #GH T | R*4 | 1/0 | WEIGHTS FUR OBSERVED DATA | +00002050 |
| c | | | | | *00002100 |
| c | NUMB | I *4 | I | NUMBER OF OBSERVATIONS FOR CLAS | S*00002150 |
| c | | | | AND TYPE BEING PROCESSED | *00002200 |
| C | | | | THE STACE OF CATA SPORTSER | *00002250 |
| c c | ITYPE | 1#4 | 1 | THE CLASS OF DATA PROCESSED | *00002300 |
| č | NDIM | I*4 | 1 | INDICATOR FOR CLASS REFERENCE | *00002350 *00002400 |
| Č | 110 114 | | • | VECTORS | *00002450 |
| č | | | | =3. FOR CLASS 1 DATA | *00002506 |
| С | | | | =6, FOR CLASS 2 DATA | +00002550 |
| c | | | | (I.E. NDIM = 2*(NUMBER OF | * 00002600 |
| c | | | | REFERENCE VECTORS REQUIRED TO | *00002E50 |
| c | | | | DEFINE ANG)) | *00002700 |
| C C | ALPR | R#4 | 1 | RIGHT ASCENSION COEFFICIENTS, | *00002750 |
| c | ALFR | Let also also | • | | *00002850 |
| đ | | | | IN RADIANS | *00002530 |
| č | DELR | R*4 | 1 | DECLINATION COEFFICIENTS. IN | *0000250 |
| С | | | | RADIANS | *00003000 |
| c | | | | | #60003050 |
| ¢ | BIAS | R*4 | 1 | HIAS FOR CLASS AND TYPE OF DATA | |
| C | | | | BEING PROCESSED | *00003150 |
| c c | IEIAS | I#4 | I | INDEX TO INDICATE DIAG HARPS | *00603200 *00003280 |
| Č | 10149 | . T- | • | INDEX TO INDICATE BIAS UNDER CONSIDERATION | *00003250 *00003300 |
| č | | | | ecucinemai ida | *00003350 |
| č | COEF | R*4 | o | RIGHT SIDE VECTOR OF SIMUL- | *00003400 |
| c | | | | TANEOUS EQUATIONS | *00903450 |
| С | | | | | *00003500 |
| <u>c</u> | RHOST | R*4 | G . | STATISTICS | *00003550 |
| c | | | | RHOST(1) - WEIGHTED SUM OF | *00603600 |
| c | | | | RESDIUALS | *00003650 |
| c c | | | | RHOST(2) - WEIGHTED SUM OF | +000003700 |
| ~ | | | | SQUARES OF RESIDUA | L500003100 |

```
RHOST(3) - SUM OF WEIGHTS
                                                                            *00003800
c
                                            RHOST(4) - MEAN RESIDUAL FOR
                                                                            *00003810
¢
                                                        TYPE I DATA
                                                                            *00003820
c
                                            RHOST(5) - STANCARD DEVIATION *00003830
c
                                                        FOR TYPE I DATA
                                                                            *A00003840
                                                                            *00003650
CCC
          ΩН
                     P#4
                               n
                                          VECTOR OF RESIDUALS
                                                                            ******
                                                                            *00003650
          ...
                     D#A
                               n
                                          VECTOR OF CALCULATED VALUES
                                                                            *00004000
¢
                                                                            *00004050
c
          SCORE
                               n
                                          MATRIX OF PARTIAL DERIVATIVES
                     C + A
                                                                            *00004100
c
                                          (DIMENSIONED NUMBER OF ELEMENTS #00004150
c
                                          IN STATE VECTOR X NUMBER OF
                                                                            *006042C0
č
                                          DESERVATIONS
                                                                            *00004250
ċ
                                                                            *00004300
c
          JONE
                                          INDEX INDICATING STARTING LUCA- #00004350
c
                                          TION OF DATA IN ARRAYS TIME.
                                                                            ±00004400
ç
                                          AXIS.ANG.WGHT.RH.CALC.SCOEF FOR #00004450
c
                                          THE CLASS AND TYPE OF DATA SEING#00604500
                                          PROCESSED
                                                                            *00004550
c
                                                                            *00004600
¢
          COMMON AREA VARIABLES USED IN THE ROUTINE
                                                                            *00004650
¢
                                                                            *00004700
¢
                     TYPE
                               DRIGIN
                                          DESCRIPTION
          NAME
                                                                            *00004750
c
                                                                            *00004800
ċ
          ICUT
                               GCNI
                                          FORTRAN DEVICE UNIT FOR SPECI-
                                                                            *******
č
                                          FIED PRINTOUT
                                                                            *00004900
č
                                                                            *00004450
                                          NUMBER OF POLYNCHIAL COEFFIC-
Ċ.
          NCOF
                               GCN1.
                     T *4
                                                                            *00005000
c
                                          TENTS FOR ALP AND DEL
                                                                            *00005050
                                                                            *00005100
C
          10×1
                               GCNI
                                          INTERMEDIATE PRINTOUT LEVEL
                                                                            *00005150
c
                                          INDICATOR (SEE REFERENCES 1 & 2
                                                                            *00005200
¢
                                          FOR VARIOUS LEVELS)
                                                                            *00005250
c.
                                                                            00520000#
c
          TZERO
                               GCNE
                                          REFERENCE TIME
                                                                            $00005350
c
                                                                            *********
¢
          rac
                               GCN1
                                          RESIDUAL STORAGE INDICATOR
                     T &A
                                                                            *****
¢
                                            =0. DO NOT STORE RESIDUALS
                                                                            *00005500
c
                                            =1. STORE RESIDUALS FOR
                                                                            *00005550
c
                                                DISPLAY AND PLOTTING
                                                                            *00CC56C0
C
                                                                            *00G05650
¢
          ICALC
                               GCN1
                                          CALCULATED VALUES STORAGE
                                                                            *00905700
¢
                                          INDICATOR
                                                                            *100005750
c
                                            =0, DO NOT STORE CALCULATED
                                                                            ±00005600
c
                                                VALUES
                                                                            *00005650
ċ
                                            =1. STORE CALCULATED VALUES
                                                                            *00005900
¢
                                                DISPLAY
                                                                            *00965950
c
                                                                            +00006000
c
         DATA TRANSMISSION
                                                                            *00C06050
¢
                                                                            ±00006100
          NAME .
¢
                    FEAD/WRITE/CPDINT
                                          DESCRIPTION
                                                                            *00006150
C
                                                                            *00006200
¢
          FTXXF001
                    WRITE
                                          INTERMEDIATE PRINTOUT. WHERE
                                                                            *00006250
c
                                          XX = IQUT
                                                                            *00006300
C
         REVISIONS
                                                                            *c0006350
C
                                                                            *00006400
C
                        F. KNOOP (20 FEE 1970) - FINAL DATE AT WHICH
                                                                            ±00006450
c
                         CODE WAS FROZEN
                                                                            *00006500
c
                                                                            *00906550
C.
                        J. WHALEN (SUMMER 1972) - INCLUSION OF LOGIC
                                                                            *00605660
C
                         TO ALLOW FOR SAVING OF THE FOLLOWING VALUES
                                                                            *00006650
Ċ
                        CALCULATED VALUES. DERIVATIVES, AND RESIDUALS
                                                                            #00006700
c
                        FOR MSAD DISPLAY
                                                                            *000C6750
C
                                                                            #00006800
                                                                            #000068850
C##
      **00006900
                                                                             00006950
c
                                                                             00607-060
c .
         THIS IS A SPECIAL SUBROUTINE CALLED BY GCONES TO COMPUTE THE
                                                                            ·00007050
         CONTRIBUTION TO THE CHEFFICIENTS OF THE SIMULTANEOUS EQUATIONS.00007100
c.
         (INVERSE COVARIANCE MATRIX) FOR EACH TYPE OF DATA. ONE TYPE
C .
                                                                            ▲00007150
         AT A TIME. THE GCONES PREAMELE AND COMMENTED LISTING PROVIDES.00007200
A DESCRIPTION OF ALL ARGUMENTS PASSED TO THIS SUBROUTINE. .00007250
C.
c.
c.
                                                                            ·00007300
                                                             • • • • • • • • • • • • • • • • • • 00007350
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SUBROUTINE COFSM (TIME.AXIS.ANG.WGHT.NUMB.ITYPE.NDIM.ALPR.DELR.BIA00007400
 ISN 0002
                    15.181AS, COSF . DRHESQ, RHOST. RH. CALC. SCOEF. JONE)
                     EXTERNAL REFERENCES NONE
                                                                                           00607500
 ISN 0003
                     COMMEN/GCNI/ICUT.NCLASS.NCLASZ.NCOF, MAXIT, IWRT.TZERG.IUC.ICALC.
                                                                                           000C755C
                                  IDER, SMULT, NP, INHERE, ISTEP, ISTOP, IRET, ISTAT,
                                                                                           00007600
                    5
                                  CCRMIN.CCRMAX
                                                                                           66667656
 ISN 0004
                     DIMENSION TIME(1).AXIS(NDIM:1).ANG(1).WGHT(1).ALPR(1).DELR(1).
                                                                                           CGGC7700
                    1
                                COFF(NP, NP).DRHOSQ(1).RHOST(3),RH(1).CALC(1),DERIV(8).
                                                                                           00607750
                                SCCEF(NP.1)
                                                                                           00407800
               C
                                                                                           44447854
 ISN 0005
                     DATA RTOD. TFLAG. X81A5 / 57.29578D0.9999999.000, 9999999.000/
                                                                                           00607900
               C ***** INITIALIZATION
                                                                                           00007950
 ISN CCCE
                     J1=JCNE-1
                                                                                           00668606
 ISN OCCT
                     IFRST=1
                                                                                           00068050
 ISN OCCE
                     N2=NCOF+NCOF
                                                                                           00008100
                 **** WRITE OUTPUT HEADER IF SPECIFIED
                                                                                           00008150
                     IF (IWRT.GE.12) WRITE (IGUT.230) ITYPE
 ISN GCGS
                                                                                           00008200
                                                                                           00008250
               c
                 **** BEGIN SUMMATION LOCK
                                                                                           00668300
                                                                                           00668350
 ISN 0011
                     BMUN.1=1 022 00
                                                                                           00608400
                     * IF TIME IS FLAGGED IGNURE THIS OBSERVATION
                                                                                           00068450
                     DATA FOR WHICH THE WEIGHT IS ZERG IS NOT PROCESSED. IF (WGHT(1).LT.0.0) GU TO 220
                                                                                           00006500
 ISN 0012
                                                                                           00006550
                     IF (TIME(I+J$).E0.TFLAG) G0 T0 220
 ISN 0014
                                                                                           00000600
               C #*** IF ATTITUDE IS INERTIAL (NCOF=1) AND HAS BEEN COMPUTED ONCE
                                                                                           00008650
               C ##### (IFRST#2) SKIP ATTITUDE COMPUTATION FROM COEFFICIENTS
                                                                                           00000200
 ISN 0016
                     IF (NCOFALE.1.AND.IFRST.EQ.2) GO TO 120
                                                                                           00006750
 ISN 0016
                     IFRST=2
                                                                                           00008800
 ISN OCLS
                     AF=0.0
                                                                                           00066650
 ISN 002¢
                     CR=0.0
                                                                                           00008900
 ISN 0021
                     IDIFF=T[ME([+J1]-TZERO
                                                                                           00000850
 ISN 0022
                     CTIME=1.0
                                                                                           00609000
              C ***** COMPUTE ALPHA AND DELTA AT TIME(I)
                                                                                           00009050
 ISN 0023
                     DO 100 JEL NCOF
                                                                                           00609100
 ISN 0024
                     AR=AR+ALPR(J)+DTIME
                                                                                           00609150
                     DR=DR+DELR(J)*OTIME
 ISN 0025
                                                                                           00009200
 ISN 0026
                     DTIME=DTIME*TDIFF
                                                                                           00009250
 ISN 0C27
                 100 CONTINUE
                                                                                           00009300
 ISN 0026
                     IF (ABS(AR).LT.10000.0.AND.ABS(DR).LT.10000.0) G8 TO 110
                                                                                           00009350
 ISN 0030
                     IF (IWRT.GE.12) WRITE (IOUT.260)
                                                                                           00005400
 ISN 0032
                     GD TO 220
                                                                                           00609450
 ISN 0033
                110 CONTINUE
                                                                                           00009500
                ***** SAVE SINES AND COSINES OF ALPHA AND DELTA AND CARTESIAN
                                                                                           00009550
              C **** COGRDINATES OF UNIT SPIN AXIS VECTOR
                                                                                           00605600
ISN 0034
                    COSA=COS(AR)
                                                                                           00609650
15N 0035
                     SINA=SIN(AR)
                                                                                           00009700
ISN 0036
                     COSD=COS(DR)
                                                                                          00609750
ISN 0037
                     SIND=SIN(DR)
                                                                                           00609800
ISN 0038
                     LI=COSD#COSA
                                                                                           00009850
PEDD MEI
                     U2=CGSD#SINA
                                                                                           00665500
15N 004C
                     U3=SIND
                                                                                           00009950
ISN 0041
                120 CONTINUE
                                                                                          00010000
              c
                                                                                          00010050
                ***** COMPUTE ANGLE AND DERIVATIVES W.R.T. ALPHAO AND DELTAG AT THE
              C.
                                                                                          00010100
              ¢
                **** CURRENT STATE
                                                                                          00010150
                                                                                          -C0 C1 02 00
              C **** COMPUTE TRUE MEASURED ANGLE (WITHOUT BIAS)
                                                                                          00010250
ISN 0042
                    GAMMA=ANG(1)
                                                                                          00610300
ISN 0043
                    IF (BIAS-NE-XBIAS) GAMMA=GAMMA-BIAS
                                                                                          00010350
ISN 0045
                    h=WGHT(I)
                                                                                          00410400
ISN 004€
                    IF (ITYPE.EQ.2) GO TO 140
                                                                                          00010450
              C **** CLASS 1 DATA - CONE ANGLE
                                                                                          00010500
ISN COAR
                    COSTHE=AXIS(1,1) #U1+AXIS(2,1) #U2+AXIS(3,1) #U3
                                                                                          00010550
ISN 0049
                    IF (ABS(COSTFE).GT.1.0) COSTHE=SIGN(1.0.COSTHE)
                                                                                          00010600
ISN 0051
                    THERAD=ARCOS(COSTHE)
                                                                                          00010650
ISN 6052
                    SINTHE=SIN(THERAD)
                                                                                          00010700
ISN 0053
                    THETA=THERAD#RTOD
                                                                                          00010750
ISN 0054
                    RHO=GAMMA-THETA
                                                                                          00910800
ISN 0055
                    IF (IDC.EQ.1) RH(I+J1)=GAMMA-THETA
                                                                                          00010850
ISN 0057
                    IF (ICALC.EQ.1) CALC([+J1)=THETA
                                                                                          00016906
ISM OCSC
                    IF (SINTHE.NE.0.0) GO TO 130
                                                                                          00010950
              C **** DERIVATIVES CAN'T BE COMPUTED. SKIP THIS POINT
                                                                                          00011000
ISN 0061
                    IF (IWRT&GE-12) WRITE (IOUT.270)
                                                                                          00011050
                    GO TO 220
ISN 0063
                                                                                          00011100
ISM GGE4
                130 CONTINUE
                                                                                          00C11150
```

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C ***** COMPUTE DERIVATIVES OF THETA W.R.T. ALPHAD AND DELTAD
                                                                                          00011200
  ISN 0065
                     DERVA=(AXIS(1,1)+U2-AXIS(2,1)+U1)/SINTHE
                                                                                          00011250
  ISN 0066
                     DERVD=(AXIS(1:1)+CO5A+5IND+AXIS(2:1)+SINA+SIND-AXIS(3:1)+COSD)/SINGO311300
                    1 1 45
                                                                                          00011350
  ISN GOET
                     GD TO 160
                                                                                          00011400
               C **** CLASS 2 DATA - DIHEDRAL ANGLE
  ISN 0068
                                                                                          00011450
                 140 CONTINUE
  ISN 0065
                                                                                          00611500
                     E1=AXIS(2+1) *AXIS(6+1)-AXIS(3+1) *AXIS(5+1)
  TSN 1007C
                                                                                          00011550
                     E2=AXIS(3,1)*AXIS(4,1)-AXIS(1,1)*AXIS(6,1)
  ISN 0071
                                                                                          00011600
                     E3=AXIS(1,1) *AXIS(5,1) -AXIS(2,1) *AXIS(4,1)
                     F=AXIS(1.1)*AXIS(4.1)+AXIS(2.1)*AXIS(5.1)+AXIS(3.1)*AXIS(6.1)
                                                                                          00011650
 TSN 0075
 ISN 0073
                                                                                          00011700
                     5V=U1*AX#S(1.1)+U2*AXIS(2.1)+U3+AXIS(3.1)
 ISN BOZA
                                                                                          00011750
                     5#=U1*AXIS(4,1)+U2*AXIS(5,1)+U3*AXIS(6,1)
 15N 0075
                                                                                          40611460
                     XNUM=U1+E1+U2*E2+U3*E3
 ISN 0076
                                                                                          00011850
                     MOEN=F-SV#S#
 ISN 0077
                                                                                          00011900
                     G1=XDEN#E1+XNUM#(SV#AXIS(4,I)+SW#AXIS(1,I))
                                                                                          00011950
 ISN OG7E
                     G2=XDEN+E2+XNLM+(SV+AXIS(5,1)+5W+AXIS(2,1))
                                                                                          00012000
 ISN 0C75
                    Q3=XDEN#E3+XNUM#(5V#AXIS(6.1)+SW#AXIS(3.1))
 ISN GOAC
                     IF (IWRT.GE.14) WRITE (IDUT.240) E1.E2.E3.F.SV.SW.XNUM.XDEN.Q1.Q2.00012100
                    103
 ISN OCES
                                                                                          00012150
                     IF (XNUM.NE. 0.0. OR. XDEN.NE. 0.0) GO TO 150
                                                                                          00012200
              C ***** THETA IS UNDEFINED AND THE DERIVATIVES CAN'T BE COMPUTED
                                                                                         00012250
 ISM DOSA
                     IF (IWRT.GE.12) WRITE (IQUT.280)
 ISN DOBE
                                                                                         00012300
                     GU TO 220
 ISN 0087
                                                                                          00012750
                 150 CONTINUE
 ISN BORE
                                                                                         00012400
                     THETA=ATAN2(XNUM, XDEN)#RTOD
 ISN ocas
                                                                                         DOOT SAKE
                     IF (THETA-LT.0.0) THETA-THETA+360.0
              C **** COMPUTE RESIDUAL AND CHECK FOR NUMERICAL DISCONTINUITY AT 0-360 GOG12550
                                                                                         00012500
 ISN 0091
                    RHO=GAMMA-THETA
 ISN CCSE
                     IF (ABS(RHO).GT.270.0) RHO=RHO-SIGN(360.0.RHO)
 ISN 0094
                    IF (IOC.EQ.1) RH(I+J1)=GAMMA-THETA
 ISN COSE
                                                                                         00012700
                    IF (ICALC.EG.1) CALC(I+J1)=THETA
                                                                                         00012750
              C ***** IF RHO IS STILL TOO LARGE ELIMINATE BY SETTING WEIGHT TO 0.0
                                                                                         00012800
 ISN OOSE
                    IF (ABS(RHC).GE.90.0) W=0.0
              C **** COMPUTE DERIVATIVES OF THETA W.R.T. ALPHAO AND DELTAG
                                                                                         00012850
 ISN 0100
                    DERVA=(-01*02+G2*01)/(XNUM*XNUM+XDEN*XDEN)
                                                                                         00012900
 ISN 0101
                    DERVD=(-Q1*COSA*5!ND-Q2*S!NA*S!ND+G3*CDSD)/(XNUM+XNUM+XDEN*XDEN)
                                                                                         00012050
 TSN 0102
                                                                                         00013000
                160 CONTINUE
              C **** SUN STATISTICS
                                                                                         00013050
ISN 0103
                                                                                         00013100
                    RHOST(1)=RHOST(1)+RHQ#W
                                                                                         00613150
ISN 0104
                    RHOST(2)=RHOST(2)+RHO*RHO*W
                                                                                         00013200
 ISN DICE
                    RHOST(3)*RHOST(3)+W
ISN 0106
                                                                                         00013250
                    IF (IWRT-LT-12) GO TO 170
              C ***** OUTPUT INTERMEDIATE QUANTITIES IN SUMMATION PROCESS
                                                                                         00413300
                                                                                         00013350
ISN 0108
                    AD=AR*RTOD
                                                                                         00013400
ISN 0164
                    DD=DR*RTOD
                                                                                         00013450
                    WRITE (10UT.250) I.TIME(1+J1).TDIFF.W.AD.DD.DERVA.DERVD.THETA.GAMMOOG13500
ISN GILC
                   1A.RHO
                                                                                        00013550
ISN 0111
                170 CONTINUE
                                                                                        00C13600
               ***** COMPUTE VECTOR OF DERIVATIVES AO, DO, A1. D1. ...
ISN 0112
                   CTIME=1.0
                                                                                         00013650
ISN 0112
                                                                                        00013700
                    00 160 J±2.N2.2
                                                                                         00013750
ISN 0114
                   DERIV(J-1)=DERVA+DTIME
                                                                                        90613800
ISN 0115
                   DERIV(J)=DERVD*DTIME
                                                                                        00013850
ISN 0116
                   CTIME=DT&ME*TOIFF
ISN 0117
                                                                                        00613900
                    IF (IDER.NE.1) GG TO 180
ISN 0119
                                                                                        00013950
                   IF (N2.GT.13) GO TO 180
                                                                                        00014000
IŚN 0121
                    SCOEF (J-1 . I+J1) = DERIV(J-1)
                                                                                        00614650
ISN 0122
                   SCOEF(J, (+J1)=DER[V(J)
                                                                                        00014100
ISN 0127
               180 CONTINUE
             C ***** SUM WEIGHTED ALPHA AND DELTA CCEFFICIENT DERIVATIVES CADSS
                                                                                        00014150
             C ***** PRODUCTS INTO COEFFICIENT MATRIX (LOWER, LEFT, DEF-DIAGONAL
                                                                                        00014200
                                                                                        00614250
             C **** IS NOT SUMMED BECAUSE OF SYMMETRY)
ISN 0124
                                                                                        00014300
                   DO 200 J#1,N2
                                                                                        00014350
ISN 0125
                   00 190 K=J.N2
ISN 0126
                   COEF(J,K)=COEF(J,K)+DERIV(K)*DERIV(J)**
                                                                                        0001445n
ISN 0127
               190 CONTINUE
             C ##### SUM CORFFICIENTS IN VECTOR CONTAINING RIGHT SIDE OF SIMULTANEOUS00414550
               **** EQUATIONS
ISN 0128
                                                                                        00014600
                   DRHOSQ(J) = DRHCSQ(J) + RHC + DERIV(J) + W
ISN 0129
                                                                                        00814650
               200 CONTINUE
ISN 0136
                   IF (BIAS.EQ. XBIAS) GO TO 220
                                                                                        00214700
                                                                                        00614750
             C ***** COMPUTE ALL MATRIX ELEMENTS DEPENDENT ON BIAS
                                                                                        00014800
ISN 0132
                   00 210 J=1.N2
                                                                                        00014650
ISN 0123
                   COEF (J. IBIAS)=COEF (J. IBIAS)+DERIV(J)+W
                                                                                        00614900
ISN 0134
               210 CONTINUE
                                                                                        00C14S50
ISN 0135
                   COEF(IBIAS, IBIAS)=COEF(IBIAS, IBIAS)+#
                                                                                        00015000
```

| ISN | 0136 | DRHOSQ(IBIAS)=DRHOSQ(IBIAS)+RHO** 00015050 |
|---------|------|--|
| ISN | 0137 | IF (IDER.EQ.1) SCOEF(IBIAS,I)=1. 00015100 |
| ISN | 0139 | 220 CGNT[NUE 00C15150 |
| | 0140 | RETURN 00G15200 |
| • • • • | | C 00015250 |
| | | C 永水水生水水还水量水水水水中中水水水平水水水 FORMAT STATEMENTS 经水中农本水水中水中平水平平水平中水中水水水水水口CC15300 |
| | | 00915350 |
| TSN | 0141 | 230 FORMAT (1X./.1X.*SUBROUTINE COFSN - ATTITUDE EQUATIONS COEFFICIENTCO015400 |
| 1 3,4 | 0.4. | 1s COMPUTATIONS FOR CLASS', [2, DATA ', //, 1x, I TIME 00015450 |
| | | 2 TOIFE WEIGHT ALPHA DELTA DERVA DEGOGIESCO |
| | | 3RVD THETA GAMMA SHO**/*2X) 00015550 |
| | | |
| I SN | 0142 | 240 FORMAT (1x.ºE1,2,3=°,3F8,4,4 F,SV,SW=°,3F8,4,° XNUM,XDEN=°,2F8,400615600 |
| | | 1,* 41,2,3=*,3F6,41 00015650 |
| ISN | 0143 | 250 FDRMAT (1X,16,5F12.4,5F12.6) 006157C0 |
| I SN | 0144 | 260 FORMAT (1x, ****** THE ABSOLUTE VALUE OF ALPHA AND/OR DELTA IS TOUGOG15750 |
| | | 1 LARGE (#100000.0 RADIANS)*) 00015800 |
| T SN | 0145 | 270 FORMAT (1x, ***** SIN(THETA)=0.0, DERIVATIVES OF THETA W.R.T. ALPCCC15650 |
| | | 1HA AND DELTA ARE UNDEFINED*) 00615900 |
| TSN | 014£ | 280 FORMAT (1x.****** PSI IS UNDEFINED, DEHIVATIVES OF PSI N.R.T. ALPODO15550 |
| 1 314 | 0146 | IHA AND DELTA ARE ALSO UNDEFINED*) 00016000 |
| | | |
| 1.5N | 0147 | END CGC16C50 |

COMPILER OPTIONS - NAME: MAIN.OPT=O'1, LINECNT #60.SIZE=0000K. SOURCE.EBCD[C.NDLIST.NODECK, LOAD.MAP.NOECIT, ID.XREF

```
00000050
                                                                        *************
             C#4
                                                                                         ********
                                                                                        ±00000200
             c
             č
                      SUBROUTINE BLKING
                                                                                         *********
             č
                                                                                         *00000300
                                                                                         ±00000350
             0000
                      CALLING SECUENCE
                                 CALL BUKING(COEF.I.J.NP.DET.IERR.STCRI.STORZ.RL)
                                                                                         *C0000400
                                                                                         ********
                      DESCRIPTION
                                                                                         *C00C0550
             c
                                 BLKINV INVERTS A SYMETRIC BLOCK GIAGONAL MATRIX
                                                                                         *00000600
             ¢
                                                                                         *00000650
             c
                                 USING A MAXINUM PIVOT STRATEGY
                                                                                         ********
                                                                                         £00000350
                      COMMON AREAS REFERENCED
             0000000
                                                                                         *******
                                 NONE
                                                                                         ********
                                                                                         *00000000
                                                                                         *0000C950
                      EXTERNAL REFERENCES
                                                                                         +00401000
                                                                                         *00001050
                                 ARS
                                                                                         *00001100
             C
                      STORAGE RECUIREMENTS
                                                                                         *00001150
             c
             c
c
                                                                                         *00001200
                                 1408 BYTES OF CORE STORAGE
                                                                                         *00801250
             č
                                                                                         *00001 100
             č
                      VARIABLES
                                                                                         #00001350
             č
                                                                                         #000C1400
             č
                       NAME
                                 TYPE
                                            t Zn
                                                      DESCRIPTION
                                                                                         *00001450
                                                                                         *00001500
             c
c
c
                                                       SYMETRIC MATRIX CONTAINING
                                                                                         *00001550
                      COEF
                                            1/0
                                 RAA
                                                       BLOCK TO BE INVERTED. ON RETURN*00001600
                                                       COEF CONTAINS INVERTED BLOCK
                                                                                         *00001650
             ¢
                                                                                         *00061700
             c
                                                       STARTING ROW AND COLUMN OF BLOCK * 00001750
             c
                                 T *A
                                            I
                                                       TO BE INVERTED
             ¢
                                                                                         #00001e00
             ċ
                                                                                         *00001550
                                 1*4
                                                       STOPPING ROW AND COLUMN OF BLOCK+00001900
             Ċ
                                            I
             Ċ
                                                       TO BE INVERTED
                                                                                         *00001950
             c
                                                                                         #00002000
             ¢
                      NP
                                  1+4
                                                       SIZE OF SQUARE MATRIX CUEF
                                                                                         *00002050
             č
                                                       (DIMENSIONED NP X NP)
                                                                                         *00002100
                                                                                         *00062150
             c
                                                       VALUE OF THE DETERMINANT
                                                                                         *00002200
                       DET
                                 A +4
                                            o
             c
c
                                                                                         *00002250
                                                       ERROR CODE
                                                                                         *00602300
                       TERR
             C
                                  1 * A
                                                         =0. NORMAL RETURN
                                                                                         *00002350
             ¢
                                                         =1. ZERO PIVOT ELEMENT.
                                                                                         #00002400
             c
                                                             INVERSE CANNOT BE OBTAINED#00002450
             C
             C
                                                                                         *00C02500
             c
                       STOR1
                                  0 * A
                                            n
                                                       WORK ARRAY(SIZE OF NF OR LARGER) # COG 02550
             C
                                                                                         *00C62600
                                                       WORK ARRAY(SIZE OF NP OR LARGER) +00002550
             C
                       STOR2
                                            0
             č
                                                                                         *00002700
                                                       WORK ARRAY(SIZE OF NP OR LARGER)#00002750
             С
                                                                                         ±00€02800
             c
                       REVISIONS
             C
                                                                                         *00002550
             Ċ
                                                                                         *00002900
             ¢
                                      J. WHALEN (SUMMER 1972) - ORIGINAL CODE AND
                                                                                         *00002950
             c
                                      TESTING
                                                                                         $00003000
             c
                                                                                         #00003050
             c
                                                                                         *60602100
                       ******************************
             C *
                                                                                         **00003150
                                                                                          00003200
                                                                                          00003250
                    SUBROUTINE BLKINY (B.LO.HI.N.DET.IER.P.Q.R)
ISN 0008
                                                                                          OCCEDODO
                    DIMENSION B(N,N),P(1),Q(1),R(1)
TSN 0003
                                                                                          00003350
                    LOGICAL#1 R
1SN 0004
                                                                                          00007400
ISN 0005
                    INTEGER HI
                                                                                          00003450
                    DET=1.
ISN 0006
                                                                                          00003500
ISN 0007
                    BO 1CO I-LO.HI
                                                                                          00003550
ISN GOGE
               100 F(I)=.TRUE.
                                                                                          00003600
ISN OCCS
                    DO 160 I±LO,HI
                                                                                          00003650
ISN 0010
                    BIG=0.
                                                                                          0.0003700
```

```
00003750
ISN 0011
                   CO 110 J=LO.HI
                    IF ((.NGT.R(J)).CR.(ABS(B(J.J)).LT.BIG)) GO TO 110
ISN 0012
                                                                                         00003800
ISN 0014
                    BIG=ABS(B(J.J))
                                                                                         00003650
ISN CCLE
                    K=J
                                                                                         00003900
ISN 0016
                110 CONTINUE
                                                                                         00003950
ISN 0017
                    CET=DET#B(K.K)
                                                                                         -00664000
ISN 0018
                    IF (BIG.EQ.O.) GO TO 170
                                                                                         00004050
ISN 002C
                    R(K)=.FALSE.
                                                                                         00604100
ISN 0021
                   F(K)=1.
                                                                                         00004150
                    G(K)=1./B(K.K)
                                                                                         00004200
TSN 0022
                    B(K,K)=0.
                                                                                         00004250
ISN 0023
                    IF (K.EQ.LG) GO TO 130
ISN 0024
                                                                                         00004300
                                                                                         00004350
ISN 0026
                    M=K-1
                   DO 120 JELO, M
                                                                                         00004400
ISN 0027
                    F(J)=B(J.K)
ISN 0028
                                                                                         00004450
                    Q(J)=B(J,K)+Q(K)
ISN 0025
                                                                                         00004500
                    IF (R(J)) G(J)=-G(J)
ISN 0030
                                                                                         00004550
ISN 0032
               120 E(J.K)=0.
                                                                                         00004600
ISN 0033
                   IF (K.EG.HI) GO TO 150
                                                                                         00604650
ISN 0035
                130 M=K+1
                                                                                         00004700
15N 0036
                   CO 140 J=M.HI
                                                                                         00004750
TEOD NEI
                   P(J)=-B(K,J)
                                                                                         00004800
SEOO NZI
                    IF (R(J)) P(J)=-P(J)
                                                                                         00004850
ISN 0C40
                    Q(J)=-B(K,J)+Q(K)
                                                                                         00604900
ISN 0041
                140 B(K,J)=0.
                                                                                         00004550
ISN 0042
                150 DO 160 J±L9.HI
                                                                                         00005000
ISN 0043
                   DO 160 K#J.HI
                                                                                         00005050
ISN 0644
                   E(J.K)=B(J.K)+P(J)+Q(K)
                                                                                         00605100
               160 B(K.J)=B(J.K)
ISN 0045
                                                                                         00005150
ISN 0046
                   IER=0
                                                                                         00505200
                   RETURN
                                                                                         00005250
ISN 0047
ISN 0C48
               170 IER=1
                                                                                         00005300
ISN 0045
                   RETURN
                                                                                         00005350
ISN 0050
                   END
                                                                                         00005400
```

COMPILER OPTIONS - NAME: MAIN.OPT=01.LINECNT=60.SIZE=0000K. SOURCE.EBCDIC.NDLIST.NDCECK.LOAD.MAP.NOEDIT.ID.XRFF

| | ***** | ****** | ******* | - | ***000001 |
|-----|----------|-------------|------------|--|----------------------|
| | | | | | *000001 |
| | | | • | | *000002 |
| 5 | CBROUTIN | E GSTAT1 | - | | *0040025 |
| _ | ALLENC C | FALIENCE | | | *000003 |
| • | ALLING S | EGUENCE | | | *0060035 |
| | | CALL GST | TATE (ALP. | ALPEND.ALPCUM.DEL.DELBND.DELCUM. | *0000049 *0000049 |
| | | | | UM.TIME1.AXIS1.ANG1.EGHT1.IFRST1. | *000005 |
| | | • | | E1 . ELASI, BBND1, RHOST1, RHO1, CALC1, | * C000055 |
| | | | | F1.TIME2.AXIS2.ANG2.WGHT2.IFRST2. | *C0 E C0 6 C |
| | | | | E2.81A52.8BND2,RHOST2,RHO2,CALC2. | *0000065 |
| | - | | | F2.AVGRHO.COEF.DRHOSQ,CHNG.STOR1, | *0000070 |
| | | | | 2.ALPR.DELR.STYPE1.STYPE2.8TYPE, GRK.B11CUM) | *0000075 |
| | | | WE 1 4 | DAN S D Z Z COM S. | *0000086 |
| D | ESCRIPTI | e N | | | *0000096 |
| | | | | | *0060055 |
| | | | | MULATIVE ITERATION RESULTS FOR | *00001:00 |
| | | DISPLAY | NG AND P | ERFORMS RESIDUAL EDITING ON THE DA | FA*00001-05 |
| | | | | . , | *0000110 |
| Ļ | GMMUN AR | EAS REFER | ENCED | | *0000115 |
| | | EL AGG. GC | N1 GDCON | | #0000120 |
| | | . 6400100 | | | *0000125 |
| E | XTERNAL | REFERENCE | s | | *0000135 |
| | | | | | *00C0140 |
| | | ABS, CHEC | K.INCORE | FTSIZE | #0000145 |
| _ | | | | | *0000150 |
| 5 | TORAGE R | EQUIREMEN | ITS | | *0000159 |
| | | 5400 OV1 | es ne co | RE STORAGE | *0000160 |
| | | 2400 011 | ES OF CO | RE STURNGE | *0000165 *0000170 |
| V. | ARIABLES | | | | *C00C175 |
| | | | | | *0000180 |
| N | A ME | TYPE | 1/0 | DESCRIPTION | *0000185 |
| | | | | | *0000190 |
| A | LP . | R*A | I | A PRIORI POLYNOMIAL COEFFI- | *0000195 |
| | | | | CIENTS FOR RIGHT ASCENSION. | *0000200 |
| | , | | | IN DEGREES | *0000205 |
| At | LPBND | R#4 | ī | CONVERGENCE BOUNDS FOR ALP. | +0000210 |
| | | • | | IN DEGREES | *0000220 |
| | | | | | *0000225 |
| A | LPCUM | T#4 | , a | CUMULATIVE RESULTS FOR ALP(1) | *0000230 |
| | =. | | | | *0000235 |
| U | EL | R#4 | 1 | A PRIORI POLYNGMIAL COEFFI- | *00C0240 |
| | | | | . CIENTS FOR DECLINATION. IN DEGREES | *0060245 |
| | | | | ac onced | *0000250 *0000255 |
| DE | ELBND | R*4 | I | CONVERGENCE BOUNDS FOR DEL. | *0000260 |
| | * * | | | IN CEGRESS | *0000265 |
| | | | • | | +0040270 |
| DS | ELCUM | ₽*4 | ជ | CUMULATIVE RESULTS FOR DEL(1) | *0000275 |
| | RGCUM | I*4 | a | | *0000286 |
| Ar | TOCUM | 1 *** | U | ITERATION INDICATOR FOR VALUES | *000C2E5 |
| | | | | IN ALPCUM, AND DELCUM | *0000290 |
| 71 | ME L | R#4 | 1 | REFERENCE TIMES FOR CLASS 1 | *0000295 |
| | | | | (CONE ANGLE) CATA | *0000305 |
| | | | | | *0000310 |
| ΑX | (ISI | R *4 | 1 | REFERENCE UNIT VECTORS FOR CLAS | |
| | | | | 1(DIMENSIONED 3*NUMBER OF CLASS | |
| | | | | 1 OBSERVATIONS) | *0000325 |
| Ah | ıG3 | R#4 | ī | CLASS 4 ACONE ANGLES COCCOVA | *0000330 |
| | | | • | CLASS 1 (CONE ANGLE) CBSERVA- Tions. In degrees | *0000335 |
| | | | | | *0000340 *0000345 |
| WG | HT1 | 兵业4 | 1/0 | CLASS 1 WEIGHTS | *0000345 |
| | | | | | *000C355 |
| 1 = | RST1 | I*4 | 1 | FOINTERS INDICATING STARTING | *0000360 |
| | | | 4 | POSITIONS FOR EACH TYPE OF | #0000365 |
| | | | | | |
| | | | | CLASS 1 DATA IN THE ARRAYS Time1.axis1.ang1.wght1 | *0000376 |

| С | | | | | 00BE0000* |
|--------|--------------|-------------|-----|--|--------------------------|
| c | NT YPE1 | I #4 | 1 | NUMBER OF OBSERVATIONS OF EACH | |
| c | | | | TYPE OF CLASS 1 DATA | *00003900 |
| c | | | | | *00003950 |
| ¢ | SIASI | 化本本 | I | ESSENTIAL ESTIMATE OF BLASES F | |
| ¢ | | | | EACH TYPE OF CLASS & DATA | *00004¢5G *00G04100 |
| c | 004B# | 0.04 | • | CONVERGENCE BOUNDS FOR BIAS! | (00004150 |
| č | BBND1 | ☆ 4 | ı | ELEMENTS | *00CD420D |
| c c | | | | ELLACIT O | *00004250 |
| C | RHOST1 | R#4 | 1 | CLASS 1 STATISTICS DEFINED AS | *000C4300 |
| č | KIIOSIE | 1000 | - | RHOST1(1.1) - WEIGHTED SUM (| |
| č | | | | ANGLE RESIDUAL | |
| č | | | | FOR TYPE I DAT | TA *00004450 |
| c | | | | RHOST1(2.1) - WEIGHTED SUM (| JF #00684500 |
| ç | | | | SQUARES OF ANG | GLE*00004550 |
| С | | | | RESIDUALS FOR | * C0904600 |
| c | | | | TYPE I DATA | *00004650 |
| С | | | | RHOST1(3.1) - SUM OF MEIGHTS | |
| c | | | | FOR TYPE I DA | |
| c | | | | HEATT (4.1) - MEAN RESIDUAL | *00004760 |
| c | | | | FOR TYPE I DA | |
| c | | | | RHOST1(5.1) - STO. DEVIATION FOR TYPE I DA | |
| C | | | | FUR TIPE I DA | *00C04790 |
| c | anos. | O 8 6 | 1 | RESIDUALS FOR CLASS 1 DATA | #CCQC4850 |
| ç | 8H0 1 | 只参车 | | DEFINED AS OBSERVED MINUS | *00004500 |
| c c | | | | CALCULATED | *00004550 |
| c | | | | 5 NE 4 0 E 1 1 E 1 | *00CC5000 |
| č | CALC1 | ₽4 4 | 1 | CALCULATED ANGLES FOR CLASS 1 | *00005650 |
| č | UNCUL | ,, | - | DATA | *00005100 |
| č | | | | | *00005150 |
| c | SCGEF1 | R*4 | I | DERIVATIVES OF CLASS 1 ANGLES | *00006200 |
| c | | | | WITH RESPECT TO STATE VECTOR | *00005250 |
| С | | | | ELEMENTS | 006300 |
| c | | | | | * 0000€350 |
| С | TIMES | R*4 | i | REFERENCE TIMES FOR CLASS 2 . | *00005400 |
| c | | | | DIHEDRAL ANGLE: DATA | *00005450 |
| c | | | | | *00005500 |
| c | AXIS2 | R#4 | 1 | REFERENCE VECTORS FOR CLASS 2 | |
| C | | | | DATA (DIMENSIONED 6 * NUMBER | *00005600 |
| c | | | | OF OBSERVATIONS. THE I TH DIHEDRAL ANGLE IS MEASURED FR | *00005650 |
| c c | | | | VECTOR((1,1),(2,1),(3,1)) TO | +00005750 |
| C | | | | VECTOR((4,1),(5,1),(6,1)) | *00005800 |
| Ç | | | | 120121111111111111111111111111111111111 | *000C5850 |
| č | ANG2 | R*4 | I | CLASS 2 ANGLES. IN DEGREES | #C0CC5900 |
| c | | | _ | | |
| ċ | #GHT2 | ₽ | 1/0 | WEIGHTS FOR CLASS 2 DATA | *00606000 |
| c | | | | | *00406050 |
| c | IFRST2 | I#4 | I | POINTERS INDICATING STARTING | +00006100 |
| c | | | | POSITIONS FOR EACH TYPE OF CL | |
| С | | | | 2 CATA IN THE ARRAYS TIME 2. | *00CC6200 |
| С | | | | AXIS2, ANG2, WGHT2 | *00006250 |
| ¢ | | | | | *00606300 |
| Č. | NTYPE2 | I *4 | 1 . | NUMBER OF CHSERVATIONS OF EAC | # #00006350 #00006400 |
| C | | | | TYPE OF CLASS 2 DATA | *00606450 |
| C | | | - | ESSENTIAL ESTIMATE OF BIASES | *00006500 |
| c | BIAS2 | F *4 | I | FOR EACH TYPE OF CLASS 2 DATA | |
| c i | | | | FOR EACH TIPE OF CEASS 2 DATA | *00006600 |
| c | 8BND2 | F*4 | I | CONVERGENCE BOUNDS FOR BLASS | *00006650 |
| č | 00102 | L. A. of | • | ELEMENTS | *00006700 |
| č | | | | , ===::=::: | +00006750 |
| č | RHOST2 | 会准备 | 1 | CLASS 2 STATISTICS DEFINED AS | *00006800 |
| c. | | | | RHOST2(1.1) - WEIGHTED SUM | QF #00006650 |
| Ċ | | | | ANGLE RESIDUA | LS *0C006900 |
| c | | | | FOR TYPE I DA | |
| c | | | | RHOST2(2.1) - WEIGHTED SUMS | |
| ¢ | | | | SQUARES OF AN | |
| Ċ | | | | RESIDUALS FOR | |
| c | | | | TYPE I DATA | * 00007150 |
| c | | | | RHOST2(3.1) - SUN OF WEIGHT | |
| c | | | | FOR TYPE 1 DA | |
| C | | | | RHOST2(4.1) - MEAN RESIDUAL | |
| c | | | | FOR TYPE I DA | |

| | | | | RHOST2(5,1) - STO. DEVIATION FOR TYPE I DATA | *00907280 *00907290 |
|---|------------|-------------------|-------------|--|--------------------------------------|
| | | | | | +00007300 |
| | 8H02 | R *4 | I | RESIDUALS FOR CLASS 2 DATA | *00067350 |
| | | | | DEFINED AS DESERVED MINUS | +00007400 |
| | | | | COMPOSED | *00007450 |
| | CALCZ | R44 | .I | CALCULATED ANGLES FOR CLASS 2 | *000C7550 |
| | | * | | DATA | #00607600 |
| | SCOEES | 73. A | _ | | *00G07650 |
| | SCOEF2 | ☆ 4 | 1 | DERIVATIVES OF CLASS 2 ANGLES WITH RESPECT TO STATE VECTOR | +00607700 |
| | | | | ELEMENTS | *00607750 *00607806 |
| | • | | | , | ±00007850 |
| | AVGRHD | R#4 | 0 | USED TO STORE AVERAGE RESIDUAL | *00007900 |
| | | | • | MAGNITUDE | *00007950 |
| | COEF | R *4 | 1 | ARRAY USED FOR COEFFICIENT | * 00008000 |
| | | ,,,,, | • | COVARIANCE. AND CORRELATION | *00008100 |
| | | | • | MATRICIES | *000C8150 |
| | | | | , | +00008200 |
| | DRHQSQ | R *4 | ī | WORK ARRAY(DIMENSIONED 13) | *00008250 |
| | CHNG | R*4 | I | WORK ARRAY USEC TO STORE THE | *00008300 |
| | | • | • | UPCATES TO THE STATE VECTOR | *00008350 *00008400 |
| | | | | AFTER EACH ITERATION | *0060845Q |
| | 57551 | | _ | | *00008500 |
| | STOR1 | R*4 | 1 . | WORK ARRAY(DIMENSIONED 13) | *000C8550 |
| | STOR2 | R*A | 1 | WORK ARRAY(DIMENSIONED 13) | *006C8600 |
| | | | - | A DOOR THE HOLD TO HED TO S | *00008650 *00008700 |
| | ALPR | ₽*4 | . 1 | RIGHT ASCENSION(ALP) CCEFFI+ | *00008750 |
| | | | | CIENTS. IN RADIANS | *00608800 |
| | DELR | R *4 | ı | DEL CIMATIONIDE: L'EDEGETOIRE | *00008850 |
| | DELIN | D | | DELCINATION(DEL) COEFFICIENTS IN RADIANS | *60668900 *00006950 |
| | | | | | +00609600 |
| | STYPEI | R*4 | ī | ALPHA-NUMERIC WORK ARRAY | *00009050 |
| | STYPES | 544 | | | *00009100 |
| | 311668 | R*4 | ı | ALPHA-NUMERIC WERK ARRAY | *0000915C |
| | BTYPE | 1*4 | I | WORK ARRAY(DIMENSIONED 13) | *00009200 *00009250 |
| | | | | | *00009300 |
| | RL · | L*1 | I | WORK ARRAY (DIMENSIONED 12) | *00009350 |
| | WORK | 6#4 | Ι. | WORK INDIVIDUES OF THE | *00009400 |
| | #UNK | 1174 | 1. | WORK ARRAY(DIMENSIONED 13) | *00€09450 |
| , | 811CUM | R#8 | a ` | ALPHA-NUMERIC WORK ARRAY USED TO | 400009500 460009550 |
| | | | | STORE CUMULATIVE BIASES FOR | *00005600 |
| | | | | DISPLAY | *00009650 |
| | COMMON ARE | EA VARTARI | ES USED IN | EGIFTING | *00005700 |
| | COMMON AND | THE TRUE | 20 0020 114 | | *00009750 *00009800 |
| | NAME | TYPE | ORIGIN | DESCRIPTION | *G0GC9650 |
| | TOUT. | ••• | | - | *00609900 |
| | IGUT | 1*4 | GCN1 | FORTRAN DEVICE UNIT FOR SPECI- | *0000555C |
| | * | | | FIED DUTPUT | *00010000 |
| | NCLA51 | I *4 | GCN1 | NUMBER OF CLASS 1 DATA TYPES | *66616656 *60910166 |
| | | | | | *00010150 |
| | NCLAS2 | 1*4 | GCN1 | NUMBER OF CLASS 2 DATA TYPES | *00010200 |
| | IRWT | I#4 | GCN1 | INTERMENTATE DETERMINE | *00010250 |
| | | - *** | | INTERMEDIATE PRINTOUT LEVEL INDICATOR(SEE REFERENCES 1 & 2 | *00610300 *00010350 |
| | | | | | *00010350 |
| | | | | | *00010450 |
| | toc | 1*4 | GCN1 | RESIDUAL STORAGE INDICATOR | *00610500 |
| | | | | | *00010550 |
| | | • | | | #00010600 #00010650 |
| | | | | | *00010700 |
| | SMULT | R*4 | GCN1 | RESIDUAL EDIT CRITERIA. (THE | *C0010750 |
| | | | | WEIGHTS OF ANGLES WHOSE MAGNI- | *00C1C800 |
| | | | | TUDE OF RESIDUAL IS GREATER THAN SMULT*(AVERAGE OF RESIDUAL MAG- | #00010850 #00010860 |
| | | | | | *00610950 |
| | | | | OF THE BROADING | *06611000 |
| | ISTEP | I#4 | GCN1 | CODDS: The second of the secon | *00011050 |
| | | • ** * | O L PA | CURRENT ITERATION INDICATOR | *00C1110C |

```
*00C11150
                                                    RESIDUAL EDIT BOUND(I.E., AVERAGE#00011200
                                ***
                                          GCN1
                     AVG
            000000
                                                    RESIDUAL FOR CLASS 1 AND CLASS 2*00011250
                                                                                     *00411300
                                                                                     #00411350
                                                                                     *00011400
                     DATA TRANSMISSION
                                                                                     *00011450
                                                                                     *00011500
                                                    DESCRIPTION
                                READ/WRITE/CPOINT
            C
                                                                                     *00011550
            C
                                                                                     *00011600
                                                    INTERMEDIATE PRINTOUT, WHERE
                     FTXXF001
            ¢
                                                                                     *00011650
                                                    xx = 100T
            Ċ
                                                                                      *00011700
            c
                                                    CUMULATIVE STATE VECTOR DISPLAY #00011750
                                CROUNT
            C
                      GSTATA
                                                                                      *00611800
            Ċ
                                                                                      *00011850
                                                    RESIDUAL EDIT DATA DISPLAY
                                CPOINT
            c
                      GSTATE
                                                                                      *00411900
            C
                                                                                      *00611950
            c
                      REFERENCES
                                                                                      *00612000
            ¢
                                    L.R.SCHLEGEL, CONES AN ITERATIVE DIFFERENTIAL
                                                                                      ±00012050
            С
                                    CORRECTION TECHNIQUE FOR ATTITUDE DETERMINATION #00012800
            ¢
                                                                                      *00612150
                                    OF A SPINNING SATELLITE. IBM FSD REPORT.
            c
                                    CONTRACT NAS 5-10022, MAY 1697
                                                                                      *00012200
            CCC
                                                                                      *00012250
                                   SURVEY AND EVALUATION OF ATTITUDE DETERMINATION #00012300
                                    TECHNIQUES, IBW FSD REPORT TR-68-8, CONTRACT
                                                                                      *00012350
             ¢
                                    NAS 5-10022. MAY 1968. PP. 4-14 TO 4-24
                                                                                      *00612400
                                                                                      +00012450
             C
                                                                                      *00012500
                      REVISIONS
             C
                                    J. WHALEN (SUMMER 1972) - ORIGINAL CODE AND
                                                                                      *00412550
             ¢
                                                                                      +00612600
                                     TESTING
             ¢
                                                                                      *00012650
             c
                                    L. FEAKES (13 JULY 1973) - MODIFICATIONS TO
                                                                                      #00612700
             C
                                    LOGIC TO ALLOW FOR BETTER DISPLAY OF CUMULATIVE #00012750
             Ċ
                                    ITERATION RESULTS AND ALTERATION OF LOGIC OF
                                                                                      *00C12800
             ¢
                                                                                      *00012650
                                    OF RESIDUAL EDITING FROM ZERO WEIGHTS TO
             C
                                     NEGATIVE WEIGHTS TO ALLOW FOR REINITIALIZATION
                                                                                      *00612900
             C
                                                                                      +00012950
                                     OF THE SYSTEM
             c
                                                                                      000E12000 €
             c
                                                                                      100013050
             SUBROUTINE GSTATE (ALP-ALPEND.ALPCUM.DEL.DELBND.CELCUM.ARGCUM.TINE00013150
LSN 0002
                  11.AXIS1.ANG1.WGHT1.IFRST1.NTYPE1.BIAS1.BBNO1.RHGST1.RHG1.CALC1.SCGGGG13200
                  2EF1.TIME2.AXI52.ANG2.WGHT2.IFRST2.NTYPE2.BIAS2.BBND2.RHQST2.RHQ2.C00613250
                  JALC2.SCOEF2.AVGRHO.COEF.DRHOSQ.CHNG.STUR1.STOR2.ALPR.DELR.STYPE1.SOU613300
                                                                                       00013350
                  ATYPE2.BTYPE.RL.#ORK.B11CUM)
                   COMBINED RESIDUAL EDITTING. CUMULATIVE DISPLAYS OF ALP(1) AND DESCOCE 3400
             C
                   COMBINED RESIDUAL EDITTING. CUPULATIVE DISPLAYS OF ALP(1) AND DELOGGISASO
             C
                                                                                       00013500
                    AND PRINTING OF DERIVATIVES IN SCOEF1 AND SCOEF2.
             c
                   DIMENSION ALP(1).ALPBND(1).ALPCUM(1).DEL(1).DELEND(1).DELCUM(1).
                                                                                       00013550
ISN 0003
                                                                                       00013600
                              ARGCUN(1).TIME1(1).AXIS1(3.1).ANG1(1).WGHT1(1).
                                                                                       00013650
                              IFRST1(1), NTYPE1(1), @IAS1(1), BBNO1(1), RHOST1(3.1).
                  2
                              RHG1(1).CALC1(1).SCOEF1(NP.1).TIME2(1).AXIS2(6.1).
                                                                                       00013700
                  3
                              ANG2(1), WGHT2(1), [FRST2(1), NTYPE2(1), ELAS2(1), BBND2(1),
                                                                                       00413750
                  Δ
                              RHOST2(3.1).RHO2(1).CALC2(1).SCOEF2(NP.1).AVGRHO(2.1).
                                                                                       00013800
                   5
                              COEF(NP, NP), DRHOSQ(NP), CHNG(NP), STOR1(NP), STOR2(NP),
                                                                                       00013850
                                                                                       00013900
                      ALPR(1), DELR(1), STYPE1(1), STYPE2(1), BTYPE(1), RL(1), WORK(1)
                                                                                       00013950
                    INTEGER#4 BTYPE, CORMIN, CORMAX, ARGCUM
15N 0004
                    REAL+B BLANK8.811CUM(5.21).DUMMY(5).DUMMY1(5)
                                                                                        00044000
ISN OCCS
                                                                                        00614050
                    DATA BLANKB/"
ISN OCCE
                                                                                        00014100
                    LOGICAL*1 RL
ISN 0007
                    COMMON/GCN1/IGUT.NCLAS1.NCLAS2.NCOF.MAXIT.IWRT,TZERG,IGC.ICALC.
                                                                                        00014150
TSN GCCE
                                                                                        00014200
                                IDER, SMULT.NP. IWHERE, ISTEP, ISTOP, IRET, ISTAT,
                                                                                        00614250
                                CCRMIN.CORMAX
                                                                                        00014300
                    COMMON /FLAGG/ FLAG.TEST
TSN OCCS
                                                                                        00014350
                    COMMEN/GDCGN/ AVG
15N 001C
                                                                                        00014400
                    CATA TFLAG/99999994/
ISN 0011
                                                                                        00014450
                    N2#NCOF#2
ISN 0012
                                                                                        00614500
                    IF (ISTEP.GT.1) GO TO 160
ISN 0013
                                                                                        00014550
                    DD 100 I±1.5
ISN 0015
                                                                                        00614600
ISN 0016
                    CD 100 J#1:21
                                                                                        00014650
ISN 0017
                    811CUM(I&J)=BLANK8
                                                                                        00014700
ISN 0C16
                100 CONTINUE
                                                                                        00014750
ISN 0019
                    ARGCUM(1)=0
                                                                                        00614800
ISN 0020
                    ALPCUM(1) #ALP(1)
                                                                                        00614650
ISN 0021
                    DELCUM(1)=DEL(1)
                                                                                        00614900
ISN 0022
                    K≠0
                                                                                        00014950
ISN 0023
                    IF (NCLASI-LE-0) GO TO 120
```

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1SN 0025
                     DO 110 I=1.NCLAS1
                                                                                          00015000
 TSN 0026
                     IF (BIAS1(1).EQ.TFLAG) GO TO 110
                                                                                          00015050
 ISN COZE
                     K=K+1
                                                                                          00015100
 ISN 0025
                     CUMMY(K)=BIASI(I)
                                                                                          00015150
 ISN 0030
               110 CONTINUE
 ISN 0031
                120 IF (NCLAS2.LE.O) GO TO 140
                                                                                          00015250
 EE00 NEI
                    DO 130 I=1.NCLAS2
                                                                                          00015300
 ISN 0034
                     IF (BIAS2(I).EC.TFLAG) GO TO 130
                                                                                          00015350
 ISM GORE
                    V-V1
                                                                                          00015400
 ISM CC12
                    CUMMY(K)=BIA52(I)
                                                                                          00015450
 ISN 003P
                130 CONTINUE
                                                                                          00015500
 TEN CORE
                140 IF (KeLESO) GO TO 160
                                                                                          00015550
 I SN DOA1
                    CALL INCORE (DUMMY, DUMMY1.15.K.8.3)
                                                                                          00015600
 ISN 0042
                    DO 150 I=1.5
                                                                                          00015650
 ISN 0043
                150 611CUM(I.1)=DUMMY1(I)
                                                                                          00615700
 TSN GG44
                160 II=ISTEP+1
 ISN 0045
                    IF (11.6T.21) GO TO 220
ISN 0047
                    ARGCHM(14)=1STER
                                                                                          00015850
 ISN CC48
                    ALPCUMCTA 1=ALP(1)+CHAG(1)
                                                                                          00015900
ISN GOAC
                    DELCUM(II) =DEL(1)+CHNG(2)
                                                                                          00615950
 ISM OCEC
                    4 - 0
                                                                                          00016000
 TEN COST
                    IF (NCLAS1.LE.0) GO TO 180
                                                                                          00016050
 ISN ODE T
                    00 170 1=1.NCLAS1
                                                                                          00016100
 TSN 00F4
                    IF (EIASI(I).EQ.TFLAG) GO TO 170
                                                                                          00016150
 ISN 0056
                                                                                          00615200
 I SN
    0.657
                    DUMMY(K)=BIASI(I)+CHNG(N2+K)
                                                                                          00016250
ISN 005E
                170 CONTINUE
                                                                                          00416300
ISN DOSS
                180 IF (NCLAS2.LE.O) GD TQ 200
                                                                                          60616350
ISN 00€1
                    DD 190 I±1,NCLAS2
                                                                                          00016400
ISN COFF
                    IF (BIASZ(1).EQ.TFLAG) GO TO 190 "
                                                                                          00016450
ISN BOFA
                    K=K+1
                                                                                          00016500
ISM DOSE
                    DUMMY(K)=8IAS2(1)+CHNG(N2+K)
                                                                                          00016550
TSN GOSE
                190 CONTINUE
                                                                                          00016600
ISN 0067
                200 IF (K-LE-0) GO TO 300
                                                                                          CCC16650
15N 0065
                    CALL INCORE (DUMNY, DUMNY1, 15.K.8.3)
                                                                                          00016700
 ISN GC7C
                    DO 210 I±1.K
                                                                                          00016750
 ISN 0071
                210 B11CUM(I.II) = 0UMMY1(I)
                                                                                          00016800
ISN 0072
                    GO TO 300
                                                                                          00616850
ISN 0073
                15.5=1 04S 00 0SS
                                                                                          00616900
ISN 0074
                    ARGCUM(I=1)=ARGCUM(I)
                                                                                          00014550
ISN 0075
                    ALPCUM(I-1) = ALPCUM(I)
                                                                                          00017000
ISM 0076
                    IF (K.LE.O) GO TO 240
                                                                                          00617050
ISM GCZP
                    00 230 J=1.K
                                                                                          00017100
TSN 0079
                230 B11CUM(J.I-1)=811CUM(J.I)
                                                                                          00C17150
ISN CCEC
                240 CONTINUE
                                                                                          00617200
15N 0081
                    ARGCUM(21)=[STEP
                                                                                          00017250
ISN OCEZ
                    ALPCUM(21)=ALF(1)+CHNG(1)
                                                                                          00017300
 ISN DOET
                    DELCUM(21)=DEL(1)+CHNG(2)
                                                                                          00017350
ISN OCE4
                    K=0
                                                                                          00017400
ISN 0085
                    IF (NCLASI.LE.O) GO TO 260
                                                                                          00617450
ISN 0027
                    DO 250 1=1.NCLAS1
                                                                                          00617500
ISN 0088
                    IF (BIASI(I).EG.TFLAG) GO TO 250
                                                                                          00017550
ISN 0090 :
                    K=K+1
                                                                                          00617600
ISN CCG1
                    DUMNY(K)=BIASI(I)+CHNG(N2+K)
                                                                                          00017650
15N 0092
                250 CONTINUE
                                                                                          00617700
ISN (0097
                260 IF (NCLAS2.LE.O) GO TO 280
                                                                                          00017750
TSN. COSE
                    DO 270 I=1.NCLAS2
                                                                                          00017800
ISN 0096
                    IF (BIAS2(I).EQ.TFLAG) GO TO 270
                                                                                          00617850
ISN 0098
                    K=K+1
                                                                                          00617900
ISN CCSS
                    DUMMY(K)=BIAS2(I)+CHNG(N2+K)
                                                                                          6661795g
ISN 0100
                270 CONTINUE
                                                                                          00011000
* ESN 0101
                280 IF (K-LE-0) GC TG 300
                                                                                          00018450
                    CALL INCORE (DUMMY, DUMMY1,15,K,8,3)
15N 0103
                                                                                          00018100
TSN 0104
                    CO 290 I±1.K
                                                                                          00018150
TEN DIDE
                290 B11CUM(I+21) = DUMNY1(I)
                                                                                          00018200
ISN 0106
                300 ISZE=II
                                                                                          00018250
                    IF (ISZE&GT.21) ISZE=21
ISN 0107
                                                                                          00018300
ISN 0164
                    CALL PISIZE (ISZE, ALPCUM, DELCUM, ARGCUM).
                                                                                          00018350
ISN GILG
                    CALL PISIZE (105.B11CUM)
                                                                                          00618400
ISN 0111
                    CALL CHECK ( *GSTATA * )
                                                                                          00018450
ISN 0112
                    CALL PISIZE (21.ALPCUM.DELCUM.ARGCUM)
                                                                                          00016500
ISN 0112
                    AVG=0.0
                                                                                          00018550
TSN D114
                    IF (IOC.NE.1) GO TO 470
                                                                                          00618600
ISN 0116
                    NCLAS=NCLASI
                                                                                         00018650
ISN 0117
                    DD 320 [=1.2
                                                                                         00018700
ISN 0118
                    IF (I.Eq. 2) NCLAS=NCLAS2
                                                                                          00018750
ISN 0120
                    IF (NCLAS.LE.O) GO TO 320
```

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00018850
                    50 310 J=1.NCLAS
ISN 0122
                                                                                           00018900
                3% 0 AVGRHO(I+J)=0.
ISN 0123
                                                                                           00018950
                JUNITION OSE
ISN C124
                                                                                           00019000
                    NUM=0
ISN 0125
                                                                                           00019050
                    NSET=0
ISN 0126
                                                                                           00019100
                    IF (NCLAS1.LE.0) GO TO 350
15N 0127
                                                                                           00019150
                    DO 340 1±1.NCLAS1
ISN 0125
                                                                                           00019200
                    J1=IFRST1(I)
ISN 0130
                                                                                           00019250
                    N=NTYPE1(I)+J1-1
ISN C131
                                                                                           00619300
                    00 330 J=J1.N
ISN 0132
                                                                                           00419350
                    OEE GT DD (DALTH-DB.(L) 19H TO 330
ISN 0133
                    IF (WGHT1(J).LT.0.0) GO TG 330
                                                                                           00019400
ISN 0135
                    AVGRHD(1-1)-AVGRHO(1-1)+AGS(RHC1(J))
                                                                                           00019450
ISN UIS?
                                                                                           00019500
ISN CLEE
                    NI:M=NUM+1
                                                                                           00019550
                330 CONTINUE
ISN 0139
                    IF (NUM.NE.O) AVGRHO(1.1)=AVGRHO(1.1)/NUM
                                                                                           00019600
ISN 0140
                    IF (NUM-NE-0) NSET=NSET+1
                                                                                           00619650
ISN 0142
                                                                                           00015700
                340 CONTINUE
ISN 0144
                                                                                           00019750
                350 NUM=0
ISN 0145
                                                                                           00019800
                    IF (NCLAS2.LE.0) GO TO 380
ISN 0146
                                                                                            00019650
                    CO 370 I=1.NCLAS2
ISN 0148
                                                                                           00419900
                    J1 = IFRST2(I)
ISN 0145
                                                                                           00019550
                    N=NTYPE2(I)+J1-1
ISN 0150
                                                                                           00020000
                    00 360 J±J1.N
ISN 0151
                                                                                           00020050
                    [F (] [ME2(J) .EG. TFLAG) GO TO 360
ISN 0152
                                                                                           00020100
                    IF (WGHT2(J).LT.0.0) GD TO 360
ISN 0154
                                                                                           00020150
                    AVGRHO(2,1)=AVGRHO(2,1)+AES(RHD2(J))
ISN 0156
                                                                                           00620200
ISN 0157
                    NUM=NUM+1
                                                                                            00020250
                360 CONTINUE
TSN 0156
                    IF (NUM.NE.O) AVGRHO(2.1) #AVGRHO(2.1) / NUM
                                                                                           00020300
ISN 0159
                                                                                            00020350
                    IF (NUM.NE.O) NSET =NSET+1
ISN 0161
                                                                                            00620400
                370 CONTINUE
ISN C163
                                                                                            00020450
              c
                                                                                            00020500
                    RESIDUAL EDITING.
                                                                                            00020550
              C.
                                                                                            00620600
                380 SUMAV=0.
ISN 0164
                                                                                            00020650
                    1F (NCLASI.LE.O) GO TO 400
TSN 0165
                                                                                            00026700
                    00 390 J=1.NCLAS1
ISN 0167
                                                                                            00020750
                     IF (IWRT.GT.20) WRITE (IOUT.530) J:AVGRHO(1.J)
ISN 0168
                                                                                            00020800
                390 SUMAY=SUMAY+AVGRHO(1.J)
ISN 0170
                                                                                            00020850
                400 IF (NCLAS2-LE-0) GO TO 420
ISN C171
                                                                                            00020900
                    DG 410 J=1.NCLAS2
ISN 0173
                    IF (INRTAGT.20) WRITE (IOUT.540) J.AVGRHO(2.J)
                                                                                            00020550
ISN 0174
                                                                                            00621 000
                410 SUMA V=SUMA V+ AVGRHD (2.J)
ISN 0176
                                                                                           -00421050
                420 AVG=SUMAN/NSET
ISN 0177
                                                                                            00421100
                    IF (IWRT.GT.20) WRITE (IOUT.550) AVG.SUMAV.SMULT
ISN 0176
                     IF (NCLAS1.LE.O.GR.SMULT.LE.O) GO TO 440
                                                                                            00021150
ISN 0180
                                                                                            00021200
                    DO 430 I=1.NCLAS1
ISN 0162
                                                                                            00621250
                     J1=[FRST1(I)
ISN 0183
                                                                                            00021300
                     I-IL+(1).134YTM=A
ISN 0184
                                                                                            00021350
                    DO 430 J=J1.N
ISN ORES
                                                                                            00021400
                     IF (ABS(RHO1(J)).GT.SMULT*AVG) WGHT1(J)=-WGHT1(J)
ISN 0166
                                                                                            00921450
                     IF (IWRT.GT.21) WRITE (100T.560) J.RH01(J)
ISN GIRE
                                                                                            00021500
ISN 6190
                430 CONTINUE
                                                                                            00021550
                440 IF (NCLAS2-LE-0-OR-SMULT-LE-0) GC TO 460
ISN 0151
                                                                                            00021600
                    DO 450 I=1,NCLAS2
ISN 0193
                                                                                            00021650
                     J1=1FRST2(1)
ISN 0194
                                                                                            00621700
                     1-11+(1)S39YTN=A
ISN 0195
                                                                                            00021750
                     DO 450 J±J1.N
ISN 0196
                     IF (ABS(RHO2(J)).GT.5MULT#AVG) WGHT2(J)=-WGHT2(J)
IF (IWRT:GT.21) WRITE (IDUT.570) J.RHO2(J)
                                                                                            00021800
ISN 0157
                                                                                            00021 650
ISN C199
                                                                                            00621900
ISN 0201
                450 CONTINUE
                                                                                            00021550
ISN 0202
                 460 CONTINUE
                                                                                            00622000
                 470 CONTINUE
ISN 0203
                     IF (IDER.NE.1) GO TO 520
ISN 0204
                     WRITE OUT THE DERIVATIVES IF COMPUTED.
                     THE GCONESR EDITING OPTION CAN BE ACCED AT THIS POINT IF DESIRED. 000222350
                                                                                            00022200
                     IF (NCLAS1+LE+0) GO TO 490
ISN 0206
                                                                                            00022250
ISN 02CE
                     CO 480 I=1.NCLAST
                                                                                            00022300
                     J1=IFRST1(1)
ISN 0209
                                                                                            00022350
                     N=NTYPE1(1)+J1-1
ISN 0210
                 480 BRITE (IQUT.580) (SCGEF1(1.J).J=J1.N)
                                                                                            00022400
ISN 0211
                 490 IF (NCLAS2-LE-0) GO TO 510
DO 500 I=1.NCLAS2
                                                                                            00022450
ISN 0212
                                                                                            00022500
ISN 0214
                                                                                            00G22550
ISN 0215
                     J1=IFRST2(I)
                                                                                            00022600
15N 0216
                     N=NTYPE2(I)+J1-1
                                                                                            00022650
                 500 WRITE (10UT,580) (SCOEF2(2,J),J=J1,N)
ISN 0217
                                                                                            -00622700
                 510 CONTINUE
ISN GE16
```

| 154 | 0219 | ED.0 | CONTINUE | |
|------|-------|-------|--|----------|
| | 0220 | . 520 | , | 00022750 |
| | | | CALL CHECK (*GSTAT1*) | 00922800 |
| 150 | 0221 | | RETURN | |
| | | С | | 00022650 |
| I SN | 0222 | 630 | SCOMAT AS AUGUSTA A TO THE TOTAL TO THE TOTAL TO | 60022900 |
| | 0223 | | FORMAT (* AVGRHO(1,*,11,*)= *,F10.5) | 00022950 |
| | | 540 | FORMAT (* AVGRHO(2:*;11.*) = *:F10.5) | 00023000 |
| 150 | 0224 | 55 û | FORMAT (AVG = ",F10.5," SUMAV = ",F10.5," SMULT = ",F10.6) | |
| I SN | 0225 | 560 | FORMAT (* RHO1(*,15.*)= *,F10.5) | 00023050 |
| I SN | 0226 | | | 00023100 |
| | | | FORMAT (RHC2(,15,) = , F10,5) | 00023150 |
| | C 227 | 580 | FCRMAT (4 +,10682.4) | 00023200 |
| ISN | 0226 | | END | 00023200 |

| COMPILER OPTIONS | _ | NAME = | MAIN.OPT=01.LINECNT=60.SIZE=0000K. |
|------------------|---|--------|---|
| | | SOURCE | EBCDIC, NOLIST, NODECK, LOAD, MAP, NUEDIT, ID, XREF |

| | | SOURC | E.EBCDIC.N | OLIST.NODE | CK, LOAD, MAP, NUEDIT, ID, XREF | |
|-----|-------------|---------------|---------------|------------------------------|--|-------------------------|
| c | : | | | | | 00000050 |
| (| · 李字章 使浓度亦非 | ·本市市市市市市市市市 | 市会在安全办办中 | ***** | ************************************** | ***00000100 |
| C | : | | | | | #00000150 #00000200 |
| • | | | | | | |
| C | | SUBROUTINE | FINAL2 | | | *00000250 *00000300 |
| (| | | | | | * 00000350 |
| C | | CALLING SE | QUENCE | | | *C0000400 |
| Č | | | A | 04080880 4 | LP.DEL.AI.DI.BIASI.EIASI.BIAS2 | |
| • | | | CALL PINAL | 44 UANUWDJS. 49 - 69 A 19 | MOSTI, RHOST 2. NTYPE1 . NTYPE2 . NCOF | *000000000 *00000500 |
| (| | | | IALLO:CO | | *00000550 |
| | 5 | | | : MEED FCE | 14 W FIGA | * 00000600 |
| 9 | | DESCRIPTIO | | | | *00000650 |
| | - | DESCRIPTIC | | | | *00000700 |
| | 5 | | EINAL2 CC | VERTS THE | INITIAL AND CURRENT ITERATION | *00000750 |
| | - | | VALUES CE | THE STATE | VECTOR INTO ALPHA-NUMERIC | *00000000 |
| | - | | | | SUMMARY DISPLAY | *000CC850 |
| | 5 | | | | | *00000900 |
| | 2 | COMMON ARS | AS REFEREN | NCED | | * 00000950 |
| | C | C 2, | | | | *00001000 |
| | Č | i . | NGNE | | | *00001050 |
| | c. | | | | • | #00001100 |
| | č | EXTERNAL F | REFERENCES | | | *60001150 |
| | _ C | | | | | *00601200 |
| | Ċ | | INCORE, PT | SIZE,SORT | | *00001250 |
| | c | | | | • | 00520000 |
| | c | STORAGE RE | EGUIREMENT: | S | | *00001350 |
| • | c | | | | | *60001400 |
| 1.1 | C | | 4224 BYTE | S OF CORE : | STORAGE | *00001450 |
| • | c | | | | | *0000150C |
| - 1 | c | VARIABLES | | | | *00001550 |
| | c | | | | | *00001600 *00001650 |
| | С | NAME | TYPE | 1/0 | DESCRIPTION | *00001830 |
| | C | | | _ | | |
| | c | GWORKO | R 市 名 | Ç | WORK ARRAY WHERE ALPHA-NUMERIC EQUIVALENTS OF PREVIOUS AND CU | |
| | C | | | | RENT VALUES OF THE STATE VECTO | |
| | C | | | | ARE STORED | *00008900 |
| | c | | | | ANE STONES | *00001550 |
| | C C | ALP | R#4 | ı | RIGHT ASCENSION POLYNOMIAL COE | |
| | c | ALF | 13.27 | • | FICIENTS. IN DEGREES | *00802C50 |
| | c . | | | | | +00002100 |
| | c | DEL | R*4 | I | DECLINATION POLYNOMIAL COEFFI- | *00002150 |
| | č | - | | | CIENTS. IN DEGREES | +00002200 |
| | č | | | | | * 00002250 |
| | c | AI | R *4 | I | INITIAL RIGHT ASCENSION POLYNO | - +00002300 |
| | C | | | | MIAL COEFFICIENTS. IN DEGREES | *00002350 |
| | c | | | | | #00G0240G |
| | ¢ | DI | R*4 | ī | INITIAL DECLINATION POLYNOMIAL | |
| | c | | | | COEFFICIENTS, IN DEGREES | *00002500 |
| | C | | | • | | * 60002550 |
| | ¢ | BIASI | A+4 | I | INITIAL BIASES FOR EACH TYPE | #000C2600 |
| | c | | | | OF CLASS 1 DATA, IN DEGREES | *00002650 |
| | c | | | _ | | *G0€02700 |
| | С | BIAS1 | R*4 | I | BIASES FOR EACH TYPE OF CLASS | +00002730 +00002800 |
| | С | | | | DATA. IN DEGREES | |
| | c | | 0.4.4 | | ANITYAL DIACEC BOD DIEL THOS | *G0002850 |
| | C | BIASZI | R#4 | I | INITIAL BLASES FOR EACH TYPE | *00002900 *00002950 |
| | c | | | | CLASS 2 DATA, IN DEGREES | 000E000# |
| | c | | | | BIASES FOR EACH TYPE OF CLASS | |
| | C | BIASZ | R *4 | I | DATA, IN DEGREES | *00003100 |
| | C | | | | DATA! IN DEGREES | *00003150 |
| | C C | RHOST1 | R#4 | ı | CLASS 1 STATISTICS | #60003200 |
| | C | Anus (L | 17 44 | • | (FOR RHOST1(1:1)-RHOST1(3:1) | *00003210 |
| | c c | | | | SEE DCCONS PROLOGUE) | #00003220 |
| | č | | | | RHOST1(4,1) - MEAN RESIDUAL | |
| | c | | | | FOR TYPE I DA | |
| | č | | | | RHOSTI(5,1) - STANDARD DEVI | |
| | č | | | | TION FOR TYPE | |
| | č · | | | | DATA | *00003450 |
| | č | | | | | 902E0900* |
| | С | RHOST2 | R ≠4 ~ | I | CLASS 2 STATISTICS | *00003550 |
| | c | | | | (FOR RHOST2(1.1)-RHOST2(3.1) | *00003560 |
| | C | | | | SEE DCCONS PROLOGUE | *00003570 |
| | | | | | | |

```
RHOST2(4.1) - MEAN RESIDUAL -- +00063600
                                                                       FOR TYPE I DATA #00003650
                                                                       STANDARD DEVIA- +00003700
                                                         AFOST2(5.11 /-
                                                                       TION FOR TYPE 1 #00003750
             ċ
                                                                                        *******
                                                                       DATA
             c
                                                                                        *00003650
                       NTVOES
                                                      NUMBER OF CLASS 1 DATA TYPES
                                                                                        *********
             c
                                                                                        *00003650
             c
             ¢
                       MITVOES
                                 ...
                                                      NUMBER OF CLASS 2 DATA TYPES
                                                                                        *******
             c
                                                                                        ******
             c
                       NCOF
                                 T = ^
                                                      NUMBER OF POLYNOMIAL COEFFICIENTS00604100
             c
                                                      FOR ALP AND DEL
                                                                                        *00004150
             c
                                                                                        ********
             c
                                                       ALLDCATION SIZE FOR GWORKO ARRAY*00004250
                       TALLO
                                                       (MUST BE 224 OR 0)
             c
                                                                                        800.004.300
             c
                                                                                        *00004350
                                                      COVARIANCE MATRIX FOR STATE
             c
                       COVAR
                                                                                        *ARCCA*AA
                                                      VECTOR ELEMENTS
                                                                                        *00004450
             c
             C
                                                                                        *00004500
                                                      NUMBER OF ELEMENTS IN THE
             c
                                 T * A
                                            T
                                                                                        #A00004550
                                                      STATE VECTOR
             c
                                                                                        ±00000A KOO
             C
                                                                                        ******
             c
                       REVISEONS
                                                                                        #00006#700
             c
                                                                                        ±00004750
                                     L. FEAKES (13 JULY 1973) - ORIGINAL CODING AND
                                                                                        *00004800
             c
                                      TESTING
                                                                                        *00004E50
                                                                                        *00004900
                                                                             SUBROUTINE FINALZ (GWORKO, ALP, DEL, AI, DI, BIASI, BIASI, BIASZI, BIASZ, RO0005650
ISN ones
                   1HOST1,RHOST2,NTYPE1,NTYPE2,NCOF, [ALLO,COVAR,NC]
                                                                                         00005100
ISN GOOR
                   DIMENSION ALF(NCOF), DEL(NCOF), AI(4), DI(4), BIASI(NTYPE1),
                                                                                         00005150
                     BIASI(NTYPE1).BIASZI(NTYPE2).BIASZ(NTYPE2)
                                                                                         00006200
                   DIMENSION RHOSTI(5.NTYPE1).RHOS12(5.NTYPE2)
ISM DOCA
                                                                                         00005250
ISN 0005
                    REAL*8 BLANKS.DUMMY(30).BIA(30).TAI,TAF,TDI.TDF.ERA,ERG,ATT(24),
                                                                                         00005300
                      GWORKO (7,32)
                                                                                         00005350
                    REAL#4 COVAR (NC.NC)
ISN CCCE
                                                                                         00005400
                    REAL*8 XBIAS/9999999.
ISN CCC7
                                                                                         00005450
                    DATA BLANKS/
ISN OCCE
                                                                                         00.005500
                   DATA ZERO/*(0)
                                        1/.ONE/!(1)
                                                         */.TWO/*(2)
                                                                                         00005550
ISN OCCS.
                                                                         4/.
                                                       ٠/,
                      THRES/*(3)
                                     .Y.TYPE/ TYPE
                                                                                         00005500
                                     17.TW01/1. 2
                      ONE1/1 1
                                                      • / . THREE1/ • 3
                                                                                         00005650
                      FOURI/ 4
                                    ' '/ FIVE/' 5
                                                                                         00005700
                      DIHED/'DIHEDRAL'/, ERROR/' EST.
                                                        */,ANGLES/*ANGLES */,
                                                                                         00005750
                      CONE/"- CONE "/.CLASS2/"CLASS 2 "/.CLASS1/"CLASS 1 "/.
                                                                                         00005800
                      INITIL/ INITIAL / FINALS/ FINAL / AALP/ ALPHA //.
                                                                                         00005650
                             DELTA '/, EIAS/' BIAS '/, MEAN/' MEAN
                                                                                         00905900
                      RESD/*RESIQUAL*/.RMS/*
                                               RMS */
                                                                                         00005950
                   DATA ACC/*ACCURACY*/
                                                                                         6666666
ISN 0010
                   REAL * 8 ZERO.CNE. TWO.THREE.TOTAL.TYPE.ONEI.TWO1.THREE1.FOURI.
TSN 0011
                                                                                         00006650
                     FIVE.SIX.CLASSI.CLASS2.DIHED.ERROR.ANGLES.CONE
                                                                                         00006100
                    SEAL®S INITIL FINALS.AALP.DDLP.BIAS.MEAN.RESD.RMS.ACC
ISN 0012
                                                                                         00006150
                   CATA INITZOZ
TSN 0013
                                                                                         00000000
                    IF (INITANE.O) GO TO 110
ISN 0014
                                                                                         00406250
ISN COLE
                    IN1.7=1.
                                                                                         00006300
1SN 0017
                    CO 100 I±1.7
                                                                                         000063504
ISN OCLE
                   DO 100 J±1,32
                                                                                         00006400
               100 GWDRKO(I:J)=BLANKB
                                                                                         00006450
ISN 0019
                    GWORKO(1.4)=ZERO
                                                                                         00606500
ISN OCEC
ISN COPA
                    GWORKO(1,5)#CNE
                                                                                         00006550
İSN 0022
                    GWORKO(1.6)=TWO
                                                                                         00606600
                    GWORKO(1,7)=THREE
                                                                                         00006650
ISN CG23
                    GWORKO(1.48)=BLANKB
                                                                                         00606700
ESN DOSA
                    GWGRKO(1412)=TYPE
                                                                                         00006750
TEN COSE
                    GWURKO(1,15) = CNE1
                                                                                         00606800
ISN 0026
                    GWORKO(1.16)=TWO1
TSN 0027
                                                                                         00006850
ISN 0028
                    GWORKO(1:.17) #THREE1
                                                                                         00606900
ISN CG29
                    GWORKO(1.18)=FCUR1
                                                                                         -00006550
ISN 0030
                    GWORKO(1,19)=FIVE
                                                                                         00007600
ISN 0031
                    GWORKO(1,24)=TYPE
                                                                                         00007050
ISN 0032
                    GWORKO (1: 27) = CNE1
                                                                                         00007100
                    GWORKO(1,28)=TW01
ISN 0032
                                                                                         00007150
                    GWORKO(1:,29) =THREE1
                                                                                         00007200
ISN 0034
                    GWORKO(1.30)=FCUR1
                                                                                         00007250
TSN 0035
                    GWORKO(1:31)=FIVE
                                                                                         0067300
ISN 0036
                    GWORKO(2:1)=INITIL
                                                                                         00007350
ISN 0037
                    GWORKO(2:2)=AALP
3500 NRI
                                                                                         00607400
```

```
GWORKO(2.10) =CLASS1
                                                                                            00007450
ISN 0035
                    GWORKO(2#12)=INITIL
                                                                                            00007500
ISN 0046
ISN 0041
                    GWORKO(2.13) =8[AS
                                                                                            00007550
                    GWORKO(2422)=CLASS2
ISN 0042
                                                                                            00007600
                    GWORKO(2-24) = INITIL
                                                                                            00007650
ISN 0043
                    GWORKO(2,25) =81AS
                                                                                            00607700
ISN 0044
                    GWORKO(3.1)=FINALS
                                                                                            00007750
TSN COAS
                    GWORKO(3.2)=AALP
                                                                                            00007800
TSN 0046
                    GWORKO(3,10) =CONE
                                                                                            00007650
ISN 0047
                    GWORKO(3,12)=FINALS
                                                                                            00007900
ISN 0048
                    CAIB=(E.L.E)OXROW
ISN 0645
                                                                                            00007950
                    GWORKO(3,22)=DIHED
ISN 0050
                                                                                            COCCROOO
                    GWDRKO(3,24)=FINALS
ISN 0051
                                                                                            pacié 65 a
ISN 0052
                    GWORKO(3.251=8IAS
                                                                                            000008100
15N 0053
                    GHORKO(4.1)=ERROR
                                                                                            00008150
ISN 0054
                    GWORKO(4.2)=ACC
                                                                                            00608200
                    GWORKO(4,10) = ANGLES
                                                                                            00008250
ISN 0055
                    GWBRKO(4,12)=ERRCR
                                                                                            00008300
ISN 0056
                    GWORKO(4.13) =ACC
ISN 0057
                                                                                            00008350
                    GWORKO(4,221 =ANGLES
ISN 0058
                                                                                            00008400
                    GWORKO(4,24)=ERROR
                                                                                            00008450
ISN 0055
ISN 0060
                    GWORKO(4.25) =ACC
                                                                                            00008500
ISN 0061
                    GWORKO(5,1)=INITIL
                                                                                            000.08550
1.SN 0062
                    GWORKO(5,2)=DDLP
                                                                                            000000000
ISN 0063
                    GWORKO(5.12) = MEAN
                                                                                            00008650
ISN 0064
                    GWORKO(5,13) =RE5D
                                                                                            00006700
ISN COSE
                    GWORKO(5.24) =MEAN
                                                                                            00006750
                    GWORKO(5+25) =RESD
                                                                                            00008800
ISN 006€
                    GWORKO(6.1)=FINALS
                                                                                            000008850
ISN CC67
                    GWORKO(6.2)=DDLP
ISN 0068
                                                                                            00008900
                    GWDRK0(6,12)=RMS
                                                                                            00008550
ISN 0065
ISN GC7C
                    GWORKO(6,13) =RESD
                                                                                            00009000
                    GWDRK0(6,24)=RMS
                                                                                            00009050
ISN 0071
ISN 0072
                    GWORKO(6.25) =RESD
                                                                                            00609100
                    GWORKO(7.1)=ERROR
                                                                                            00609150
ISN 0073
ISN 0074
                    GWORKO(7.2)=ACC
                                                                                            00009200
                110 J=0
                                                                                            00009250
TSN 0075
                    0G 120 I=1.4
                                                                                            00009300
ISN 0076
                    IF (I.GTANCOF) GO TO 130
                                                                                            00009350
ISN 0077
                                                                                            00009400
ISN BOTS
                    J=J+1
                    ATT(J)=AT(I)
                                                                                            00009450
ISN GCEC
ISN OCEL
                    J=J+1
                                                                                            00009500
                    ATT(J)=ALP(I)
ISN DOES
                                                                                            00005550
ISN OCES
                    1+6=2
                                                                                            00609600
ISN DCE4
                    ATT( J) = SQRT( COVAR(2 + I - 1 + 2 + I - 1 ) )
                                                                                            00005650
ISN 0085
                                                                                            00609760
                    1+し=し
ISN COLE
                    (I) MC=(L) TTA
                                                                                            00009750
                                                                                            00609800
ISN OCE7
ISN 0088
                    ATT(J)=DEL(I)
                                                                                            00009850
ISN 0085
                    J+L=L
                                                                                            00609900
ISN CCSO
                    ATT(J)=SQRT(CGVAR(2*1,2*1))
                                                                                            00009950
ISN 0091
                                                                                            00010000
                126 CONTINUE
ISN 0092
                130 I=I*J
                                                                                            60010050
                    CALL INCORE (ATT.DUMMY,15,1,8,3)
ISN 0093
                                                                                            60610100
                    DO 150 J=1.4
ISN 0694
                                                                                            00010150
                    ©0 150 1≈2.7
IF (JaGTaNCOF) GO TO 140
                                                                                            60410206
ISN DOSE
ISN DOGE
                                                                                            00010250
ISN 0098
                    GWORKO(I.J+3)=DUMMY(I-1+(J-1)*6)
                                                                                            00E01600
ISN OCSS
                    GO TO 150
                                                                                            00010350
ISN 6100
              1 140 GWORKO(I+J+3)=8LANK8
                                                                                            00616466
ISN 0101
                150 CONTINUE
                                                                                            00010450
ISN 0102
                    GWDRKO(2.8)=BLANK8
                                                                                            00010500
ISN 0103
                    GWORKO(3,8)=BLANK8
                                                                                            00010550
                    GWORKO(4.8)=BLANK8
ISN 0104
                                                                                            00010600
ISN 0105
                    GWORKO(5.8)=8LANK8
                                                                                            00010650
ISN 0106
                    GWORKO(6+8)=BLANK8 ...
                                                                                            00016700
ISN 0107
                    GWORKO(7.8)=BLANK8
                                                                                            00010750
ISN 0108
                                                                                            00010800
                    J=0
ISN 0109
                    IF (NTYPE1.LE.O) GO TO 170
                                                                                            00010850
ISN 0111
                    DO 160 I=1.NTYPE1
                                                                                            00010900
ISN 0112
                    J=J+1
                                                                                            00010950
ISN 0113
                    8IA(J)=0+D0
                                                                                            00011000
ISN 0114
                    [F (BIASI(I).LT.XBIAS) BIA(J)=BIASI(I)
                                                                                            00611650
                    1=1+1
ISN 0116
                                                                                            -00611100
ISN 0117
                    E1A(J)=0.DO
                                                                                            00011150
ISN CILE
                    IF (BIASI(I)+LT+XBIAS) BIA(J)=BIASI(I)
                                                                                            00011200
ISN 0120
                                                                                            60011250
ISN 0121 --
                    -0-0-(L)AIB
```

```
IF (BIAS1(I).LT.XBIAS) BIA(J)=SGRT(CGVAR(2*NCOF+I.2*NCOF+I))
                                                                                            00011350
ISN 0122
                                                                                            00011400
ISN 0124
                    J=J+1
                    BIA(J)=RHGST1(4.1)
                                                                                            00011450
ISN 0125
                                                                                            00611500
19N 0126
                    1=2+1
                    61A(J)=RHOST1(5.1)
                                                                                            00011550
TSN 0157
                160 CONTINUE
                                                                                            00011600
TEN ATTE
                    IF (NTYPEL GE . 6) GC TO 190
                                                                                            00011650
ISN G129
                                                                                            00611700
                170 ASBIAS=NTYPE1+1
ISN C171
TON 0175
                    DO 180 IK=NSPIAS.5
                                                                                            00011250
ISN: 0133
                    00 180 IL=1,5
                                                                                            00611800
ISN 0134
                    J=J+2 →
                                                                                            00411850
ISN 0135
                    BIA(J)=0.
                                                                                            00011900
ISN 0136
                180 CONTINUE
                                                                                            00011550
                190 CONTINUE
                                                                                            00012000
ISN 0127
1SN 0138
                    1=25
                                                                                            00012050
                    CALL INCORE (BIA-DUMKY-15-1-8-3)
                                                                                            00612100
15N 0179
                    00 200 J±1.5
D0 200 I=2.6
                                                                                            00012150
ISN DIAC
                                                                                            00012200
TSN 0141
                    GWDRKO(1,J+14)=DUMMY(1-1+(J-1)*5)
                                                                                            00012250
ISN 0142
ISN 0143
                200 CONTINUE
                                                                                            00612300
TSN 0144
                    J=0
                                                                                            00012350
ISN 0145
                    IF (NTYPE2.LE.O) GO TO 220
                                                                                            00012400
1SN 0147
                    DO 210 [=1.NTYPE2
                                                                                            00012450
ISN 0148
                    J=J+1
                                                                                            00612500
ISN 0145
                    EIA(J)=0.D0
                                                                                            00012550
ISN OLSC
                    IF (BIAS2I(I).LT.XBIAS) BIA(J)=EIAS2I(I)
                                                                                            00912600
TSN 0152
                    J=J+1
                                                                                            00012650
                    BIALUN=0.DO
                                                                                            00012700
ISN .0153
                    IF (BIAS2(I).LT.XBIAS) BIA(J)=BIAS2(I)
ISN 0154
                                                                                            00012750
ISN 0156
                    1= 149
                                                                                            00012800
ISN 0157
                    00-0-(L)A1B
                                                                                            00012850
ISN 0156
                    IF (8IAS2(1).LT.X8IAS) 8IA(J)=SQRT(CDVAR(2*NCDF+NTYPE1+1.2*NCDF+NT00012900
                   1 YPE1+1))
                                                                                           00012950
ISN C160
                    J=J+1
                                                                                            0061 3000
ISN 0161
                    8 IA(J)=RHO5T2(4.1)
                                                                                            00013650
ISN 0162
                    J=J+1
                                                                                            00013100
                    BIA(J)=RHOST2(5.1)
                                                                                            00613150
ISN 0162
TSN 0164
                210 CONTINUE
                                                                                            00013200
                    IF (NTYPE2+GE+6) GC TO 240
ISN 0165
                                                                                            00013250
                220 NSBIAS=NTYPE2+1
ISN 0167
                                                                                            00613300
                    DO 230 IK=NSBIAS.5
DO 230 IL=1.5
ISN OLEE
                                                                                            00013350
ISN 0169
                                                                                            00013400
ISN 0176
                    J=J+1
                                                                                            00013450
ISN C171
                    PIA(J)=0-
                                                                                            00013500
ISN 0172
                230 CONTINUE
                                                                                            00013550
ISN 0173
                240 CONTINUE
                                                                                            00613600
ISN 0174
                    1=25
                                                                                            00013650
                    CALL INCORE (EIA.DUMKY.15.1.8.3)
15N 0175
                                                                                            00013700
ISN C176
                    CO 250 J=1.5
                                                                                            00013750
ISN 0177
                    00 250 I±2.6
                                                                                            00013800
                    GWORKO(1, J+26)=DUMMY(1-1+(J-1)*5)
ISN 0178
                                                                                            00013850
                250 CONTINUE
ISN 0179
                                                                                            00013900
                    CALL PISIZE (224.GWORKO)
ISN C180
                                                                                            00023950
ISN 0181
                    FETURN
                                                                                            00614000
ISN. 0182
                    END
                                                                                            00014050
```

| COMPILER | OPTIONS - NAME: MAIN, OPT=01.LINECNT=60.SIZE=0000K. SOURCE.EBCDIC.NOLIST.NODECK.LOAD.MAP.NOEDIT, ID.XREF |
|----------|--|
| c | ************************************* |

| | | | | CK & EUND FINE PRODUCTION - | 00000050 |
|--------|-----------|--------------|---------------|---|----------------------------|
| *** | ****** | **** | ******* | 表示教育的 化苯基苯甲基基苯甲基基苯甲基苯基苯甲基苯基苯基苯基苯基 | *00000100 *00000150 |
| | | | | | *60600200 |
| | | | | | *c00C0250 |
| | SLOROUTIN | E GDCCGN | | | *00CC0300 |
| | | | | | *00000350 |
| | CALLING S | EGLENCE | | , | *00000400 |
| | | CALL COC | CONTINUATION | ALLS.IFRST1.IFRST2.NTYPE1.NTYPE2. | *00000450 |
| | | CALL GUC | PHR1.8H | 2.GWORK4.GWORK5.IALLO | #00000500 |
| | | | | | *COCC0550 |
| | DESCRIPTI | ГN | | | ≑ ŲŮÕŮÕÕÕŨ |
| | DESCRIP | | | • | ⇒00000650 |
| | | GOCCON S | TORES THE C | CMPUTED RESIDUALS INTO WORK | *00000700 |
| | | ARRAYS F | OR PLOTTING | AND CALLS THE WSAD RELATED | *00000750 *00000800 |
| | | TABLES T | O DISPLAY T | HE PLOTS | *COCC0850 |
| | | | | | *00000900 |
| | CEMMON AR | EAS REFER | ENCED | | *00000550 |
| | | | | | *0CC01000 |
| | | DCSOPT.G | CNI | | *00001650 |
| | EXTERNAL | GES COF NO E | c | | *00001100 |
| | EXTERNAL | CHECK PT | | | *00001150 |
| | | CHECK II | | | *00001200 |
| | STODAGE R | EQUIREMEN | NTS | | #00001250 |
| | 310000 | | | · · | #00601300 |
| | | 1786 BY | TES OF CORE | STORAGE | *00.001350 |
| | | | | | #00601400 |
| | VARIABLES | ì | | | *00001450 |
| | | | | | *00001550 |
| | NAME | TYPE | 1/0 | DESCRIPTION | *CGCC1600 |
| | | | _ | ALLOCATION SIZE OF GWORK4 ARRAY | |
| | IALL | I # 4 | 1 | ALLECATION SIZE OF CHOMES AND | *00001700 |
| | | | _ | ALLOCATION SIZE OF GWORKS ARRAY | #00001750 |
| | IALL5 | [*4 | I | ACEGCA TON SIZE OF THE | *00001800 |
| | | • • • | 1 | POINTERS INDICATING STARTING | *00001650 |
| | IFRST1 | 1 *4 | • | POSITIONS FOR EACH TYPE OF CLAS | S*00601900 |
| | | | | 1 DATA IN THE RHOL ARRAY | *60008550 |
| | | | | | *00C02000 |
| | IFRST2 | [*4 | 1 | POINTERS INDICATING STARTING | *00002050 |
| | •· ··• | | | POSITIONS FOR EACH TYPE OF CLAS | ********** |
| | | | | S DATA IN THE SHOZ ARRAY | *00002150 *00602200 |
| | | | | C ORCEDUATIONS OF CACH | *00002250 |
| | NTYPE1 | I #4 | I | NUMBER OF OBSERVATIONS OF EACH | #00602300 |
| | | | | TYPE OF CLASS & DATA | *00002350 |
| | | | | NUMBER OF COSERVATIONS OF EACH | #00902400 |
| | NT YPE2 | I *4 | ĭ | TYPE OF CLASS 2 DATA | *00002450 |
| | | | | TIPE OF CENES E SILL | +00002500 |
| | | | 1 | RESIDUALS FOR CLASS 1 DATA | *00002550 |
| | RH01 | 和本本 | • , | DEFINED AS DESERVED MINUS | *00002600 |
| | | | | CALCULATED | *00C02650 |
| | | • | | * | *00002760 |
| | RH02 | R#4 | I | RESIDUALS FOR CLASS 2 CATA | * 00 0 02750 |
| | | | | DEFINED AS OBSERVED MINUS | +00002800 |
| | | | | CALCULATED | *00002E50 |
| | | | | | *00602900 |
| | GNORK4 | R#4 | 0 | WORK ARRAY FOR STORAGE OF OBSE | |
| | | | | VATION NUMBERS FOR EACH CLASS | 000E0000 |
| | | | | AND TYPE OF DATA | *00003050 |
| | | | | and the second of peri | 90003100 0-0003150 |
| | GMORK5 | 日本年 | C | WORK ARRAY FOR STORAGE OF RESI | 00120000# - 0 |
| | | | | UALS FOR EACH CLASS AND TYPE O | *00003250 |
| | | | | DATA | *00003300 |
| | | | • | ALLOCATION SIZE OF GWORKO | *00003350 |
| | IALLO | I*4 | Ī | (MUST BE 224 OF 0) | +00003400 |
| - | | | | (MOST OF FE4 DI OT | *00003450 |
| | CONNON | 4054 U401 | ABLES USED 1 | IN ROUTING | #00003500 |
| : | CCMMUN : | PIZEM ANGE | | | *00003550 |
| • | NAME | TYPE - | ORIGIN | DESCRIPTION | *00003600 |
| ; | | | - · · | | *00003650 |
| : | NAME | | | | |
| ; ; | CPTION | 1*4 | DCSOPT | | 4S #00003700 |
| : | | 1*4 | DCSOPT | FLAG ARRAY FOR PLOTTING OPTION =0, DO NOT PLOT =1, PLOT | |

```
c
                         FINISH
                                    T + A
                                              DOSUPT
                                                         FLAG FOR TERMINATING PLOT
                                                                                            ±00003900
               200
                                                         OPTION TABLE
                                                                                            *00003550
                                                           =0. DO'NOT TERMINATE
                                                                                            #00CC4600
                                                           =1. TERMINATE
                                                                                            #06604.050
               c
                                                                                            *00004400
               c
                         FINALD
                                    T # 4
                                              DOSUPT
                                                         FLAG FOR DISPLAYING SUMMARY
                                                                                            *00004150
                                                         DISPLAY
                                                                                            *00004200
               C
                                                           =0, DO NOT DISPLAY
                                                                                            *000004250
               C
                                                           =1 . DISPLAY
                                                                                            *000004300
               ¢
                                                                                            #00000# 950
               ¢
                         NCLASI
                                                         NUMBER OF CLASS 1 GATA TYPES
                                   1 44
                                              GCNI
                                                                                            *00004400
               ċ
                                                                                            *00004450
               c
                                              GCNI
                         NCLAS2
                                   1 * 4
                                                         NUMBER OF CLASS 2 DATA TYPES
                                                                                            *00004=00
               c
                                                                                            4000004550
               č
                                                         RESIDUAL STURAGE INDICATOR
                         TOC
                                   1 * 4
                                              GCN1
                                                                                            *00C04600
               c
                                                           =0. OU NOT STORE RESIDUALS
                                                                                            *00004650
               ¢
                                                           =1. STORE RESIDUALS FOR
                                                                                            *40000A700
               Ċ
                                                               PLOTTING
                                                                                            *******
               c
                                                                                            $00 C04 B00
               c
                        DATA TRANSMISSION
                                                                                            ********
              С
                                                                                            *00004900
               ċ
                        NAME
                                   READZWRITEZCEGINT
                                                         DESCRIPTION
                                                                                            *00004550
               č
                                                                                            *00005000
               Č
                        DRESI 1
                                   CROINT
                                                         RESIDUAL PLUT FOR CLASS 1 TYPE
                                                                                            *00005050
               c
                                                         1 CATA
                                                                                            *00.0051.00
              č
                                                                                            *00C05150
              c
                        DEES12
                                   CROINT
                                                         RESIDUAL PLOT FOR CLASS 1 TYPE
                                                                                           *00005200
              C
                                                                                            *00005250
                                                                                            *00005300
              C
                        DRES13
                                   CROINT
                                                         RESIDUAL PLOT FOR CLASS 1 TYPE
                                                                                           #0000E350
              Ç
                                                         3 CATA
                                                                                            *00665466
              Č
                                                                                            *00005450
              C
                        ORES14
                                   CFOINT
                                                         RESIDUAL PLOT FOR CLASS 1 TYPE
                                                                                           *00005500
              c
                                                         4 CATA
                                                                                            *00005550
              č
                                                                                            *00¢¢5500
              C
                        ORES15
                                   CROINE
                                                         RESIDUAL PLOT FOR CLASS 1 TYPE
                                                                                           *00005650
                                                         5 DATA
                                                                                            *00005700
              c
                                                                                           *00005750
              000
                        DRES21
                                   CPOINT
                                                         RESIDUAL PLOT FOR CLASS 2 TYPE
                                                                                           *00.CC580C
                                                         1 DATA
                                                                                           *00405£50
                                                                                           *00065900
              c
c
                        DRESEZ
                                   CPOINT
                                                         RESIDUAL PLUT FOR CLASS 2 TYPE
                                                                                           *00005550
                                                         2 DATA
                                                                                           *00006000
              C.
                                                                                           *00006050
              c
                        DRES23
                                   CPOINT
                                                         RESIDUAL PLOT FOR CLASS 2 TYPE
                                                                                           *C0C06100
              c
                                                        3 DATA
                                                                                           *00006150
              С
                                                                                           *00C06200
              C
                        DRES24
                                   CROINT
                                                        RESIDUAL PLOT FOR CLASS 2 TYPE
                                                                                           *00006250
              Ç
                                                                                           00E30000*
              0000
                                                                                           02E30000*
                        DRES23
                                   CENTAL
                                                        RESIDUAL PLOT FOR CLASS 2 TYPE
                                                                                           *00006400
                                                                                           *00006450
                                                                                           *00C06500
              C
C
                        DEINDR
                                   CPGINT
                                                        SUMMARY DISPLAY
                                                                                           *00006550
                                                                                           *00006600
              Ç.
                        OBTABL
                                   CPGINT
                                                        FLOT OPTION TABLE DISPLAY
                                                                                           *00G06650
              ¢
                                                                                           *00006700
              Ċ
                        REVISIONS
                                                                                           *C00C6750
              Ċ
                                                                                           *00C06B00
              C
                                       L. FEAKES (13 JULY 1973) - ORIGINAL CODING AND
                                                                                           *00406850
              ¢
                                       TESTING
                                                                                           *00006900
              *00006650
                                                                                           *00007000
              [] 武武城 未决章和 以来 龙水太寺市 李本本 李宗汉宋 张本本本 由北本本 自 水土 对 火火
                                                                                      *******00007650
                    SUBROUTINE GOCCON (IALL4.IALL5.IFRST1.IFRST2.NTYPE1.NTYPE2.RHO1.RH000C7100
ISN 0002
                   162,GWGRK4,GWGRK5,IALLOJ
                                                                                            00007150
                    DIMENSION GWCRK4(1).GWORK5(1).RFG1(1).RHO2(1),IFRST1(1).IFRST2(1) COCC7200
ISN 0003
15N 0004
                    DIMENSION NTYPE1(1), NTYPE2(1)
                                                                                            00007250
ISN CCC5
                    CCMMON/GCN1/ ICUT.NCLAS1.NCLAS2.NCOF.MAXIT.IRWT.TZERO.IGC.ICALC.
                                                                                            00007300
                   1 IDER.
                                                                                            00007350
                      SMULT.NP.INHERE, ISTEP. ISTOP, IRET. ISTAT. CORMIN. CORMAX
                                                                                            00007400
ISN 0006
                    COMMON/DCSUPT/ OPTION(10), FINISH, FINALD, IMESG(8)
                                                                                            00007450
15N 0007
                    INTEGER#4 OPTION.FINISH.FINALD.CCRMIN.CORMAX
                                                                                            00007500
ISN OCCE
                    IFINSH=0
                                                                                            00007550
                100 IF (IFINSH.NE.O.AND.FINISH.EQ.1) GO TO 320
15N 0005
                                                                                            00007600
ISN CC11
                    IFINSH=1
                                                                                            00007650
```

С

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00007700
                   IF (IOC.EG.O.GR.IALL4.EG.O.DR.IALL5.EG.O) GO TO 300
ISN 0012
                                                                                          00007750
                    IF (NCLASS .LE.O) GO TO 200
ISN 0014
                                                                                          00007600
                   00 190 1=1.NCLA51
ISN 0016
                                                                                          C0667850
                    1F (OPTION(I).NE-1) GO TO 190
15N 0C17
                                                                                          00007900
                    ICOUNT=0
ISN 0015
                                                                                          00007550
                    K=0
ISN 0020
                                                                                          0008000
                    IFRES=0
ISN 0021
                                                                                          occecso
                    JJ1 = IFRST1 (I)-1
15N 0022
                                                                                          00008100
                    NN=NTYPE1(I)
TSN -0023
                                                                                          00008150
                    IF (NN.LE.O) GO TO 190
ISN 0024
                    NN1=1
ISN 0026
                                                                                          00008250
                110 DO 120 JENN1 .NN
ISN 0027
                                                                                          00608300
                    ICOUNT=ICOUNT+1
ISN 0028
                                                                                          00008350
                    K=K+1
ISN 0C25
                                                                                          00008400
                    GWORK5(K)=8HC1(JJ1+J)
ISN 0030
                                                                                          00008450
                120 GWORK4(K) = ICCUNT
1SN C031
                                                                                          CGCCE500
                    IF (K.EG.IALLE) IFRES=1
ISN 0032
                                                                                          00006550
                    CALL PISIZE (K,GWORK4,GWORK5)
ISN 0034
                                                                                          00005600
                    60 TO (130.140.150.160.170). I
ISN 0035
                                                                                          00006650
                130 CALL CHECK ( *CRES11')
ISN 0036
                                                                                          00008700
                    GO TO 180
ISN 0037
                                                                                          00006750
                140 CALL CHECK ( DRES121)
15N 0038
                                                                                          00008800
                    GO TO 180
ISN CCES
                                                                                           00008650
                150 CALL CHECK ( DREST 3.)
ISN GOAC
                                                                                          00008900
                    GO TO 150
15N 0041
                                                                                           00008550
                160 CALL CHECK (*DRES$4*)
ISN 0042
                                                                                           00009000
                    60 TO 180
ISN 0043
                                                                                           00009050
                170 CALL CHECK (*DRES15*)
ISN 0044
                                                                                           CCC09100
                180 IF (IFRES.NE.1.0R.J.EG.NN) GO TO 190
ISN 0045
                                                                                           00009150
                    IFRES=0
ISN 0047
                                                                                           00009200
                    N1=K+1
ISN COAE
                                                                                           00009250
                     K=0
TSN 0049
                                                                                           00009300
                     GD TO 110
15N 0050
                                                                                           00009350
                190 CONTINUE
ISN 0051
                                                                                           00009400
                200 IF (NCLAS2 LE .O) GG TD 300
 ISN 0052
                                                                                           00005450
                     CO 290 I=1.NCLAS2
 ISN 0054
                                                                                           00005500
                     IF (CPTIGN(5+1).NE.1) GO TO 290
 ISN 0055
                                                                                           00009550
                     JJ1 = [FR5T2(I)-L
 ISN 0057
                                                                                           00005600
 ISN 0058
                     K=0
                                                                                           00009650
                     ICOUNT=0
 15N 0059
                                                                                           00009700
                     NN=NTYPE2(I)
 ISN 0060
                                                                                           00009750
                     NNX=1
 ISN 0061
                                                                                           00009800
                     IF (NN-LE-0) GG TU 290
 ISN 0062
                                                                                           00005850
                     IFRES=0
 ISN 0064
                                                                                           60609900
                 210 00 220 JENNI .NN
 ISN 006E
                                                                                           00669950
                     K=K+1
 ISN COEE
                                                                                           0061 0000
                     ICOUNT=ICOUNT+1
 ISN. 0067
                                                                                           00010050
                     GWGRK5(K)=RHC2(JJ$+J)
 ISN 0068
                                                                                           00010100
                 220 GWORK4(K)=ICCUNT
 ISN CC69
                                                                                           00010150
                     IF (K.EQ.IALLS) IFRES=1
 ISN 0070
                                                                                           00010200
                     CALL PISIZE (K.GWORK4.GWORK5)
 ISN 0072
                                                                                           00010250
                     GO TO (230,240,250,260,270), I
 ISN 0073
                                                                                           00010300
                 230 CALL CHECK (*DRES21*)
 ISN 0074
                                                                                           00010350
                     GO TO 280
 TSN 0075
                                                                                           00010400
                 240 CALL CHECK ( *DRFS22*)
 ISN 0076
                                                                                           00010450
                     GD TO 280
 ISN 0077
                                                                                           00010500
                 250 CALL CHECK ( DRES23 )
 ISN GC7E
                                                                                           00010550
 ISN 0075
                     GO TO 280
                                                                                           00210600
                 260 CALL CHECK (*DRES24")
 ISN 0080
                                                                                           00010650
                     GO TO 280
 ISN OCE1
                                                                                           00010700
                 270 CALL CHECK ( DRES251)
 ISN 0082
                                                                                            C0010750
                 280 IF (IFRES.NE.1.OR.J.EG.NN) GO TO 290
 ISN OCES
                                                                                            0000,0800
                     TERES#0
 ISN 0085
                                                                                            00010850
                     NN1=K+1
 ISN OCEE
                                                                                            00020900
 ISN 0067
                     K=0
                                                                                            00010950
                     GO TO 210
 ISN CCRE
                                                                                            00011000
                 290 CONTINUE
 15N 0CES
                 300 IF (IALLO.EG.224.AND.FINALD.EG.1) CALL CHECK (*DFINDS*)
                                                                                            00011050
 ISN OGSC
                                                                                            00011100
                     CO 310 IOPT=1.10
 15N 0092
                                                                                            00031150
                 310 GPTICN(IGPT)=0
 ISN CCSE
                                                                                            00011200
                     FINALD=0
 ISN G094
                                                                                            00011250
                     CALL CHECK ( *CPTAB1 *)
  ISN 0095
                                                                                            CGC11300
                     GU TO 100
  ISN CCSE
                                                                                            00011350
                 320 RETURN
  ISN 0097
                                                                                            00011400
                     END
  15N 0658
```